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ECLIPSE OR EMPIRE?

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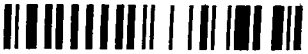

PREFACE

In presenting this book to the Public we have to express our general acknowledgment to the Authors of the various books referred to in the footnotes. We desire also to thank Mr. Cloudesley Brereton for his kindness in looking over the MSS. of our Educational chapters, and for his valuable advice thereon. We wish further to place on record our great sense of indebtedness to those who have made contributions to the Glossary of this book, and to Mr. Angus Watson and Professor Perkin for their monographs, which appear in the body of the work.

It should be understood that chapters iv, v, vi and vii, which deal with Educational problems, are not intended to be other than mere suggestive outlines. The subject is too vast and complicated to be dealt with in any comprehensive form within the compass of this book. Notably we have omitted any reference to the need of a reformed education for girls and women, which is of pressing importance to the country.

Our main object in this as in other directions is to create the consciousness of a need rather than to dogmatize on the methods to be applied.

H. B. Gray.
S. Turner.

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ECLIPSE OR EMPIRE?

PART I

CHAPTER I

THE MESSAGE

FORTY years ago Great Britain was still the workshop of the world. To-day she is not.

She owes her present high position to a combination of many happy circumstances, but, above all, to the fact of her original supremacy as an industrial nation. With the loss of that supremacy she loses all. That is our first postulate. It will be shown in the course of these pages that in the field of industry we have for many years been expecting and expected to make bricks without straw, and that the Pharaoh against whom we have been struggling is to be found enthroned in the hardness of our own hearts, in our reluctance to change and our prejudice in favour of the old.

This is no vague generality. Facts and figures are arrayed in these pages to prove that a large percentage of the new ideas and inventions which have been given to the world during the last forty years have issued from nations other than our own.

A study of the Glossary will show that the value and utility of those ideas and inventions have been more quickly appreciated, appropriated, and applied in foreign lands, and that it is our apathy in seizing hold and making use of them which has kept them from our own. Here again

facts and figures tell their own tale. They form indeed the very pith of our book; apart from them it would never have seen light. But we have been stirred to our task by the strength of our conviction that their combined testimony is fraught with the gravest consequence to Nation and Empire. We urge the reader, therefore, to study the digest of evidence embodied in the glossary before he proceeds further, or, at latest, at the end of the second chapter. Then, and not till then, let him return to judge the case.

Statistics have always had an evil reputation. They have been branded as a superlative form of lies. It is on record that even Chancellors of the Exchequer abhor them. The late Lord Randolph Churchill gave vent to a highly spiced aversion to "those——dots." Canning, a more polite politician, was the reputed author of the saying, "Nothing is so fallacious as facts except figures." Like most epigrams, it has its shallow and its serious side. Doubtless, to serve private ends or to secure a rhetorical victory, both facts and figures may be so manipulated as to prove or disprove anything and everything. But no such sinister design is harboured in this book. The authors have no axe to grind; no possible end to gain except their country's good. They are two men, precluded by age or circumstance from more active service, who have believed that they could best "do their bit" by throwing the weight of their energies into the work of investigation in the cause of organic reform. Their contention is that, if sincerely and scientifically set forth, facts and figures have an eloquence all their own, and carry a conviction which cannot be gainsaid. But they claim a special value for those presented in these pages. They are not a musty collection dragged from museums and encyclo-

pædias. Wide travel by both writers in Europe, America, and the Overseas Dominions, coupled with some public service on the part of the one, and ramified business experience on the part of the other, has led them during the past fifteen years to visualize the industrial conditions prevailing in Great Britain and in other countries respectively. Impressed by the vital consequences of the contrast, they have gathered together a mass of material "red hot" from office and factory, put at their disposal by men of affairs who have no cause to serve except that of unvarnished truth. They are prepared, if challenged, to back up their facts and figures.

But though this book deals mainly with the industrial field, its survey has by no means been confined to that sphere. Otherwise it might be open to the charge of flinging its light exclusively on one side, and one which, in some elegant circles, is still regarded as the material and even vulgar side of the national life, with which the soul of the nation might be deemed to have no concern. Such criticism is shallow and betrays a vulgarity of its own. Surely there is a soul in industry. A perfect machine is not the mere metal out of which it is welded. It is rather the embodiment of human sweat and tears, of human sacrifice. Viewed thus broadly, it is an embodied tribute to the invincibility of the human spirit.

But the writers have not lost sight of the fact that industrial progress is only one of the complex energies of the national life. They hold that the same imperviousness to ideas which has impeded the free play of our industries may be traced in the sphere of government and in the professions, as well as in the social and religious organisms. Incidental references, therefore, to all these will be made in

the course of this work. But above and beyond all else, Education is the burden of their song. On it, vested interests, tradition, and prejudice have for many generations laid heavy and paralysing hands. And yet, inasmuch as the child is the father of the man, from educational efficiency or inefficiency must spring the moral and intellectual health or maladies of the community which grows up under its shadow.

Many inter-acting influences, racial, geographical, and climatic, have been at work in shaping the features of our people's history and colouring its complexion. It is generally agreed that most of those influences have on the whole strengthened and quickened rather than enfeebled and undermined the national vitality in the process of the centuries. If some of them have made progress slow, they have made it sure. Other and more disagreeable features are recognized as having had a contrary effect, such as the scandalous housing of the poor, the outworn system of the land laws and of land tenure, and in later years the insular character of the Imperial Government, all of which are symptomatic of an ill-organized condition of the Body Politic.

But, in the opinion of the writers, the root-cause of all that makes for decay, warping political foresight, throttling the Civil Service with infinite folds of red tape, fossilizing High Command, narrowing the purview of social life in all grades, and shrivelling industrial fruitfulness in employer and employed alike, is to be found in the lack (in spite of all that has been attempted hitherto) of a proper system of national education for all classes in the land from the highest to the lowest. This subject will be further expounded in chapters iv, v, vi, vii.

THE MESSAGE

Our book is addressed to the Man-in-the-Street, and in such a shape, it is hoped, that he who runs may read. The facts and figures set forth may possibly command the attention of some in authority; doubtless they will compel the criticism of the expert; but they have not been compiled with either of these ends in view. Primarily and chiefly they utter a voice to the People.

There is a design in this form of appeal. Proof has not been wanting lately that public opinion in Great Britain, usually so slow to assert itself, has under pressure of these fateful days forged ahead of the men in office. It shows a tendency to lead its leaders, to take the law into its own hands, to force measures, to instigate movements, to become increasingly impatient of compromise—that blessed word so dear to the Anglo-Saxon mind. The fact is—John Bull has been hit hard on the head, and the blow has at last roused him from his somewhat stertorous slumber of half a century. To begin with, his eyes have been opened to the truth that all is not safe in the island home. Bolts from above the clouds, bolts from beneath the waters, have made assaults upon her virgin security.

But more than that—the Man-in-the-Street has learnt with a shock of sharp surprise that her industrial supremacy during the last forty years has been threatened, and in part usurped, by alien Powers—gradually, stealthily, but unmistakably, and often in spheres which once seemed peculiarly her own. The war has aroused him to the fact that a policy of industrial penetration had been organized and pursued on a scale far beyond what he had even dimly conjectured. Foreigners had crept in unawares in such numbers and in such insidious ways that, when the Day of Armageddon came, their sinister influence was discoverable

in almost every quarter of national activity. This truth was brought home to him in all sorts of ways. Bitter experience taught him to realize that the nation had become dangerously dependent on its enemies in many key industries, while by State subsidies and other means those enemies had, in many cases, practically wiped out British industries altogether. All this through the inertia of himself and his rulers.

Warnings had not been wanting from time to time on the part of those who knew; but they had been disregarded, and even ridiculed. Only since the period of popular discovery have Press and Platform combined to speculate on the causes of our defects, and to suggest remedies.

Newspapers and magazines have laid their fingers on some of the worst blots, and have been persistent in urging the need of organic change. And they have carried with them a great weight of public opinion. Abundant evidence of this fact may be found in the enormous number of letters contributed to the Press by all sorts and conditions of men, calling for a complete overhauling of our educational system.

Nevertheless, in spite of all this insistence, the danger is lest the consensus of public opinion should after all fail to force reform. Some sort of focus seems to be required, permanently concentrated on the object of its vision. The Press has done splendid work in flashing its light on dark corners, but obviously, on account of its diurnal motion, it fails to secure fixity of impression. Moreover the eye of the newspaper-reader is being perpetually distracted by miscellaneous records of daily events in various fields of human activity, and this distraction tends to blunt his energy in urging drastic action on any particular issue.

The Platform has the disadvantage which must always attend oratory; the force of its impression dwindles hourly from the date of its expression; while of the action of Committees there has arisen a not unwarranted suspicion that they often serve as organized instruments for blocking measures of urgency, and for doing nothing at all when the heat of urgency cools.

Again, the Man-in-the-Street may hold strong views of his own, but his robust common sense demands facts in support of views before he pushes principles into practice, and forces his political guides along the path of reform. In this mood and with this end in view, we ask him to read this book—a book which doubtless will be little more than a focus of much that has been spoken, written, and thought within the last few months—but still a book which is designed to bring searchlights of its own to bear on some of those vital problems, and more particularly the educational problem, which will press for speedy solution at the end of the war. For it is abundantly certain that, unless the Man-in-the-Street insists on their solution as a matter of immediate urgency, and if the nation relapses again into its wonted apathy, Great Britain, however victorious in arms, is doomed by the laws of progress to sink gradually into the position of a second-class Power.

The force of this book then must lie rather in facts and figures than in opinions or inferences. It does not pretend to be exhaustive of its subject; it seeks to stimulate further inquiry, while it concentrates public thought. Its aim is to arouse rather than to depress. Far from uttering jeremiads, it is meant to be a call to put on strength. Though it has no desire to provoke controversy, it yet sounds the alarm of peace, that there will be "war after

war." Finally it designs to awaken the consciousness of an urgent need rather than to dogmatize on the kind of remedies to be applied.

Nevertheless it would be idle to pretend that strong views will not be found implied or expressed. To omit judgment on what seem to be patent truths, or to avoid obvious deductions from ascertained facts, would in the eyes of the writers be a breach of duty to the country which they have set themselves to serve.

Again, let this be clearly understood at the outset. No political ends, no economic views, no industrial interests, no educational bias, have influenced our pages. No formulæ of any kind have been shunned or embraced. The times are too tragic for such temper or treatment; men will not brook party spirit when a whole world is out of joint. The truth, the whole truth, and nothing but the truth is our aim. To this end let every reader study the Glossary; let him read, mark, learn, and inwardly digest it. Then let him apply its analysis to his own particular calling; for we dare to maintain that he will find it applicable to most parts of the field of human activity in these islands. The cogency of the facts quoted is self-evident. Their muster will be found startling and even alarming. It will be seen that they cover a wide area of modern life, and that, though a bare outline only is presented, they nevertheless embody the judgments of many thoughtful men as to the general condition of their country, and sometimes convey hints as to the remedies to be applied. The enormous importance of these facts when seen in combination can scarcely be exaggerated.

Over this vast array then let the eye of the reader range at will; and the lamentable fact will be brought home irresistibly to his mind that in much that goes to make up

the sum total of a civilized community—in the sphere of household and office, field and farm, factory and hospital—this country is in the leading strings of other and alien nations.

"War after war"—not so much upon our enemies or our rivals as upon ourselves—our own old ways, our own old prejudices and preconceptions, social, industrial, and educational, but above all educational—is the only road to future peace, future prosperity, and future power.

CHAPTER II

THE ENGLISHMAN AT HOME

NEVER in the history of Great Britain has there been a moment more auspicious for a parting of the ways. The whole metal of the nation is in the melting-pot, and has to be re-cast. The values of life are being everywhere re-adjusted. The true proportions of things that matter are seen in clearer relief; the fabric of social relations has been rent in twain from the top to the bottom. Under the stress of war men clasp hands who once walked aloof. In the trench and factory new fellowships have sprung into life. Class differences tend to be blurred. "Conservative" and "Liberal" are terms partly consigned to limbo. Voices from Overseas begin to be heard in dominant counsel. "Tariff Reform" and "Free Trade" are being viewed in new and strange lights.

Our rulers will soon be forced to solve the problem of meeting the demand of millions of returning soldiers who will no longer tolerate sexless or servile occupations, and will demand new work and new homes. It will be a crime against Great Britain if these men are lost or wasted. There will be an instant call for firm and bold measures so framed as to bring into use the huge acreage of the land of our country now lying untilled. Scientific agriculture and afforestation must be developed. All our untold and hitherto partly unemployed resources, industrial and commercial, must be dragged from darkness into light.

There must be a general revival of energies. Finally a scheme of State Emigration to our Overseas Dominions, backed by State subsidies, must be set on foot, though only as a last resource for unabsorbed labour.

Meanwhile under the stern pressure of war, capital and labour are being shaken together and may end in shaking hands. Even in the religious world burning controversies tend to smoulder and be snuffed out. Everywhere men (and women too) are beginning to walk together as if they were agreed, and, what is more, they are being taught by the most pressing of all necessities to frame their lives less on precedent, and to strike out on new lines.

All things conspire to prove that England can never be the same England again. There is, in fact, a tacit but general confession that never in our history has there been such an opportunity for impressing new resolves and enforcing changed conditions on the Body Politic.

But what new principles, what new movements, will issue from this welter it is far more difficult to forecast. Men who live in the midst of stupendous events are apt to be seized with a mental paralysis. The veil of mystery hangs over the horizon of the future. Yet a call no less imperious than that of war impels us to send this book into the world at this momentous hour. True that the instant struggle on which Great Britain is engaged is one which spells life or death for herself and her Empire, and that in pursuit of this great cause the lives of her best sons are being offered up in hourly sacrifice. Yet meanwhile at home a vague feeling is slowly but everywhere asserting itself that much is wrong with our national condition.

It would be well to ask ourselves, that we may learn

to know each other better and set right what is wrong, what kind of people we were when the alarm of war broke in upon our slumber on August 4, 1914.

Certain difficulties lie in the path of self-analysis. The English people are an abnormally sensitive race; they resent the familiarity involved in being interpreted to the world. Their self-depreciation is a cult, which, however, if analysed, not seldom resolves itself into a deep-seated consciousness of each other's infirmities. The icy reserve in some classes, and gruffness in others, which treat a stranger as an enemy, are relics of an insularity of which the possession of an Empire has not yet ridded them, though it is a subject of jibe in the mouths of their brethren overseas. Their very tricks of speech betray their distrust of themselves and of each other. They are in constant fear of giving themselves away. Worshippers of precedent, they detest originality and brand self-expression as self-advertisement. Versatility is looked upon with suspicion; eccentricity is voted a crime. They are, in fact, the most crushing people upon earth. And yet under this veneer, this crust of mock humility, they hide an intense self-esteem and a calm and confident belief in their superiority over mankind, thanking God inwardly that they are not as other men are. Sound mediocrity, if properly weighted with social influence, is a passport to success, though the possession of ideas, if backed by the possession of ancestry, is no bar to office. It is indeed condoned and sometimes applauded. There may be much latent strength in these peculiar national idiosyncrasies, but it is perhaps a matter of surprise only to themselves that Englishmen are not universally beloved in the world outside, and that, because their language seems sometimes to belie their deeds, they

are placarded as hypocrites when they come into contact with foreigners.

Nevertheless many things go to prove that a large number of thoughtful people are ready to admit radical changes in the national life, or at least to listen to proposals for its reconstruction. In nearly all classes the social conscience has been awakened and is even alert. Luxury, the deep-seated ulcer of the prosperous, has been probed, if not excised. Self-denial has seized on the throne long usurped by selfishness. Anxiety and bereavement have found their best relief in the stress of public work. The flood of charity with apparently inexhaustible tide daily bursts into new channels. There is abundant proof that the soul of the nation is awakening. Under the touchstone of national peril, the dross and the gold, the sham and the real, are self-revealed. And there is nothing more hopeful for the cause of reform than self-revelation.

There are certain difficulties, however, which stand in the way of reform:

1. The Briton is of all men the most jealous of any inroad by the State on his purse or liberty, for which he can discover no immediate recompense.

2. He is an islander; an ocean, and not a mere stream, or mountain pass, or painted sign-post, has for centuries served as his frontier. No forest of bayonets bristles on his borders to keep him in constant fear of attack. Never has he hitherto felt, as have Continental nations in all stages of their history, that sore need of State Aid to protect him from engirdling enemies.

3. The spirit of independence, engendered by his Saxon ancestry and by his seafaring life, has subtly spread through the land in the process of the centuries, and has bred in the

Briton an individualism which refuses to bow down before the image of the State.

4. The servitude from which a large section of the people suffered up to the middle of the last century—the servitude to a squirearchy—was only feudal and parochial. It taught them nothing as to their duties to a higher master. The rapid gravitation of the masses from the countryside to the towns succeeded indeed in partially killing feudalism, but simply substituted a municipal for a parochial allegiance.

5. This mental attitude was fostered by another racial instinct—the passion for sport. The energies of the worker, cooped up all the week in the close atmosphere of industrial toil, found a vent in local spectacular contests. Hence the absorption, so astounding to other nations, in provincial cricket and football. The ideal of Nationalism and of Imperialism, except here and there in its more insular form which regards Great Britain as the hub, and the "Colonies" as spokes in the wheel, seems to leave the Islander cold, though it sets on fire the soul of the Son of Empire from Overseas.

6. There is a sixth and more subtle cause which may account for the popular reluctance, specially in the sphere of industry, to tolerate any organization of the life of the individual by the State. It is a matter of comparatively modern history. It dates from the spread of the economic principles taught by the Manchester School in the nineteenth century, and pursued by a large section of employers who, however upright in their motives, carried these principles into practice in ignorance of the logical issues to which they led. This School thought of the processes of industry mainly in terms of production. They did not realize production and consumption as interacting agencies.

The doctrine that wages are determined by a ratio between Capital and Population, or, in other words, that wages must be made to depend on the balance between the demand and the supply of labour, ruthlessly exploited by many unscrupulous employers, led to intense industrial bitterness. Trade Unions owe their birth and growth to this tyranny, which it became their laudable design to defeat and crush. Unhappily, with this end in view, and to ensure the employment of a larger number of workers, an artificial restriction began to be put on the energy and output of the individual. The Trade Unions drove a wedge between the individual and the State, and became the fount of authority and the unit of industrial control. In arising to correct the original culprits, they gradually usurped the power which the rulers of the State were too supine or too one-sided to exercise.

Meanwhile the policy of restricting output has contributed to an immense loss of wealth to the nation, and to a gradual transference of trade and industry to other countries. No nation that puts a minimum of its strength into labour can hope to compete with another which works at full blast.

The war has already given us an object lesson in this obvious truth. In spite of the fact that some millions of men are on active service in the field, the startling fact has been made plain that the country as a whole has a bigger aggregate output than ever. America and Germany have during the last quarter of a century been working at the very end of their tether. Great Britain has put forth only a tithe of her strength.

Happily of late, and forced by events, the eyes of the people are being opened to the perilous predicament in

which our national industries stand. The discovery has suddenly been brought home that the organization of the country must be undertaken by the Government, and that those industries in particular which are the life-blood of her power must be safeguarded in the interests of the State. This seems to be the meaning of Mr Runciman's speech on January 3, 1916. *It will, in fact, be apparent to all close observers, that a country which fails to regulate and foster its industries in the national interest cannot in the nature of things long survive the rivalry of another country where the industries are so regulated and fostered.*

Whence comes this organization which has done so much for our enemies and rivals and so little for ourselves in the field of industry? It seems to spring from two main causes—education and temperament.

The Premier of Australia in one of his inspiring speeches declared that "the gulf between Heaven and Hell is not wider than the gulf between England and Germany." It is at once the hope and the belief of many patriots that geographically, morally, and socially, that gulf will not for many years to come be bridged. But there seems no reason why we should not learn from other nations the causes which make for success in industry. The basis of organization—is that spirit of self-discipline which subordinates the interest of the individual to the harmonious working of the whole. Nor need there be any fear of our thus becoming bound in fetters to the State, or being mere docile units of a tyrant-will. Democracy with its native spirit of distrust and resistance will see to that and be the best guardian of its own liberties. It is indeed

sometimes said that a democracy is incapable of organization. The example of industrial America, however, does not seem to justify such a statement. Nor do we maintain that organization is everything; it is only contended (as everyone who has ears to hear can readily perceive) that the times loudly call for its application in the sphere of industry as well as in other spheres.

Notwithstanding her lack of organization, Great Britain enjoys many counter-balancing advantages—amongst others her geographical position, the nearness of her products to her ports, and the cheapness of her money. These combined factors, unless checked, so far from making us despair of the future, rather indicate the transitory character of her comparative ill-success in competition with neighbours and rivals. Nay, more, they will make her industrial supremacy as certain in the future as it was undisputed in the past, if we will only organize.

Unhappily, as things are, wherever our eyes turn they are confronted with evidence proving the baneful results of unorganized licence which involves the absence of real liberty. For liberty, to be real for every individual, can only co-exist with the exercise of self-discipline for the greater good of his neighbour. Nothing could have been more subversive of real liberty, for instance, than the uncontrolled licence in house-building, which has created the slums of our great cities and the hideous erection of unplanned towns. Here liberty for the individual has meant the virtual enslavement of hundreds of thousands.

Again, no one unacquainted with our land system would believe that more than half the area of England and Wales is owned by 2,500 people out of a population of nearly

35,000,000; that is to say, by only one man out of every 14,000. Yet this astounding fact has been the gradual outcome of the freedom allowed to one man of doing what he likes with his own. But what of the enormous consequences, social, economic, industrial, to the lives of 13,999 of his fellow-countrymen? The growth of manufacturing industries has doubtless led to the gravitation of the population from the countryside into towns. But the liberty of the landowner to do what he likes with his own has also been partly responsible for the figures which show that 77 per cent. of the population are dwellers in the towns and only 23 per cent. in the country.

Or, if a survey be made of the field of education, the same untrammelled individualism will be found to have asserted itself there also.

As, however, a more lengthened consideration of this particular matter is reserved for later chapters, the writers are content to repeat without further comment a quotation, to which one of them ventured to call attention in a former work of his own, from no less an authority than Mr. A. J. Balfour, and which expresses pungently the unorganized condition of English education:—"The existing educational system of this country is chaotic, is ineffectual, is utterly behind the age, makes us the laughing stock of every advanced nation in Europe and America, puts us behind not only our American cousins, but the German, the Frenchman, and the Italian."

CHAPTER III

THE SLACKENING OF MOMENTUM

IMMEDIATELY after the war of American Independence and the subsequent struggle with Napoleon, an immense impetus was given to British Trade by the conclusion of peace. There was an outburst of the long-pent-up reserves of our natural resources, together with a rapid repair of wasted population. It is significant that high taxation did little or nothing to check this twofold development. During the first half of the nineteenth century the population of the United Kingdom rose from ten to twenty millions. It is a still more significant fact that no less than seventeen millions of that increased number were being fed on home-grown wheat—a proof that the sturdy race of yeomen still flourished in the land, and that the population was still more largely rural than urban. Agricultural rents rose from twenty-two million pounds in 1800 to double that amount in 1850. Meanwhile the eighteen chief towns in England had trebled their population. These two facts—the vigour of the yeoman, and the increase in numbers of the town workers—when combined, show sufficiently the extraordinary expansion of prosperity in the period under survey. In spite of high taxation there was an economic output such as the world had never seen before. The wars which lasted from 1775 to 1815 had infused into the people of England the spirit of work. Taxation and thrift go hand in hand; and great ideas are the offspring of labour.

Inventions followed one another with startling rapidity. The British textile industries showed marvellous development. The import of cotton increased thirteenfold, wool tenfold, and silk sevenfold, in forty years. The production of iron increased sevenfold. In 1845 Great Britain produced 64 per cent. of the world's total tonnage of coal. She became, in fact, "the workshop of the world."[1]

This momentum (in comparison with that of other nations) reached perhaps its full strength in 1851, the year of the Great Exhibition, and just before the outbreak of the Crimean War; though during the thirty years following Britain still remained supreme in the world's main industries. Since that period, *i.e.*, 1881, ten years after the end of the Franco-German War, the momentum has gradually been getting less and less, while the encroachment of other nations has made rapidly increasing strides.

What cause has led to this slackening of the moral and economic pulse in the life of the nation? Surely it is to be found in the operation of the same psychological factor which exerts itself in the career of the individual. When a man attains to dignity or office which he has won by incessant struggle, but in the tenure of which he thinks himself henceforth secured, he is sometimes overtaken by a sluggishness foreign both to his original temperament and his previous exertions—a sluggishness which becomes more incurable as years advance. The Civil Servant with a certain prospect of a pension, or the Ecclesiastic secure in the possession of his freehold, may possibly occur to some minds as examples of this "sleeping sickness."

Compare the condition of agriculture in England in 1916

[1] See the article in the *Nineteenth Century*, December, 1915, "Britain's War Finance and Economic Future," by J. Ellis Barker.

with what it was thirty years ago, bearing always in mind the fact that (according to our enemies) England is no longer an island, and that (according to our own scientists) there is in normal times only a two months' margin between ourselves and famine.

1. The amount of island-grown wheat has fallen nearly 20 per cent. in the last thirty years, whilst that of Germany has increased at least 50 per cent.

2. The yield per acre in England has during that period remained practically stationary, while that of Germany has gone up 40 per cent.—largely the result of artificial fertilizers, of which Germany makes use to the extent of 105 lbs. per acre, while the United Kingdom is content with the application of 48 lbs. Germany, as the war has shown, has thus largely solved the problem of feeding its population by intensive cultivation.

3. Only 5 per cent. of the cultivated land in the United Kingdom is devoted to-day to wheat production. In fact, her agriculture has decayed, and that decay has caused incalculable loss.[1] It is estimated that if, out of her forty-six and a half millions of acres under cultivation, she were to devote eight millions to wheat, she would be self-supporting as regards her wheat supply. This would require a drastic change in the uses to which the land of England is at present put. Nor is the present unsatisfactory state of Agriculture compensated for by increased stock-raising, for while our stock has remained almost stationary during the period named, Germany's stock has increased by 33⅓ per cent.

[1] See *The Spirit of the Soil*, by G. D. Knox, especially the chapter on "England's Food Supply"; also *Germany's Economic Progress and National Wealth*, 1888-1913, by Dr. Karl Helfferich.

Who are the world's best industrial workers to-day? It is possible to answer this question in the light of a few salient figures. Doubtless contributory causes may in some cases be cited, subjecting their full value to dispute or attack. But the general inference to be drawn from the comparative tables given below is unassailable. They comprise a short list of industries closely bound up with the wants of the community, and they show the value of the annual output in pounds sterling of English and American workers per man employed in the industry. They are extracted from the Census of Production of the two countries taken in 1907 and 1909 respectively.

	United Kingdom.	United States.
Boot and shoe trade	£171	£346
Cocoa, chocolate, confectionery ..	296	662
Cutlery and tools	164	323
Clothing	158	484
Hats and caps	149	414
Hosiery	184	309
Leather	686	1,054
Matches	223	625
Paper	330	705
Printing and publishing	396	572[1]

So then a survey of these industries of the two nations shows that the wage-earner in the United States produces far more *per diem* than his fellow-workman in the United Kingdom, and this in spite of the fact that he does not work longer hours. Yet forty years ago the statement could be made that "A given number of hands in Great Britain perform much more work than is executed by the same number of hands almost anywhere else." But that referred to a period when Great Britain had earned and really deserved the title of "the workshop of the world."

[1] See the Glossary.

Again, thirty years ago (1886), the average cost of extracting coal at the pit's mouth in England was 4s. 10d. per ton; in 1912 it was 9s. 0¾d. In the United States it was 6s. 4½d. in 1886; in 1912 it was 6s. 1d.; that is to say, while the cost has increased in Great Britain by 4s. 2¾d. per ton, in America it has decreased by 3½d.[1]

Let us look at the comparative table of Iron and Steel production in Great Britain and Germany respectively during the last fifty years.

	Iron.		Steel.	
	In Germany. Tons.	In Great Britain. Tons.	In Germany. Tons.	In Great Britain. Tons.
1865	975,000	4,896,000	100,000	225,000
1913	19,291,920	10,479,171	18,958,819	7,663,876

It will be seen that, whereas in 1865 Great Britain produced roughly five times as much iron, and two and a quarter times as much steel as Germany, in 1913 Germany produced almost twice as much iron, and two and a half times as much steel as Great Britain; and this, notwithstanding the fact that our country is geographically the most favourable in the world for producing and distributing her products, since she has both coal and iron close to her ports.

But if the agriculture of Great Britain has declined in the last forty years, if her output of iron and steel has been outstripped, and if her coal-mining costs her more than it did, it might at least be supposed that she could fairly boast that she still holds premier place in the volume and value of her export trade. It is true that this trade has shown expansion in the last twenty years, but it is equally and more significantly true that her rivals have shown far greater progress. While England increased her

[1] See the Glossary.

exports of manufactured goods between 1886 and 1906 by sixty millions of pounds, Germany increased hers by eighty-three millions.

From all points of view then England has been slowly losing momentum as compared with her past self and with her rivals, in the period under survey. And all these things have happened under the shelter of democracy to a nation which boasts herself to be the freest the sun has ever looked upon, free as the air she breathes, with her free trade, with her free food and free education, and her free and almost truculent declaration every day that "Britons never shall be slaves."

So the practical question comes to be: "Can a democratic community evolve a discipline all its own, can it shoulder it cheerfully, can it make itself as efficient as an autocracy?" If it cannot, then autocracies must bear in future the lordship of the world.

The only path of salvation for a democracy is to set its face towards self-discipline. In itself it is a negation of discipline. Left to itself it has a tendency to pull half its weight in time of peace, and to put forth only a part of its strength in time of war. The writers, as true lovers of democracy, dare, from their very love of it, to suggest in bare outline how for the future we can set our house in order.

The State ought to express *ourselves*. We must be her debtors as well as her creditors. We have hitherto been prone to look upon her too much as a milch-cow from which to draw incessant sustenance. Education, Insurance, Pensions, we demand them all at her hands. In a word, the contract is entirely of a charitable and not of a mutual character.

This international war has taught us that this one-sided

contract must be cancelled and re-drafted. The State herself must in future be the predominant partner. If she is to take care of us when we are ill, she must be allowed partially to direct our lives when we are well. If we are to be cared for by her in old age, she must compel thrift when we are young. She must not only control our education, but, while leaving free play to individual energy, she must employ machinery of her own, which will develop to their utmost limit the resources of the country. She must, in fact, be the foster-mother of every activity in all industrial and scientific spheres. And we, in our turn, ought to realize that we are the servants of the State—that she is our Over-soul—the great constructive power which, so far from stifling, develops individual energies. She could and should provide us with a riot of opportunity.

A democracy in ancient days cramped the free life of the individual. What the State did not command that it forbade. The pendulum of modern democracy has swung the other way, and stuck there. Our modern creed is that what the State does not command that she allows; and if she does anything to displease us we defy her. It is the religion of *laissez faire.*

It is now being seen that this doctrine ultimately spells death to a nation. The only condition on which a democracy can flourish is that every individual should find his highest expression in the State, and in return for the benefits which she bestows on him he should offer to her his best powers and his ungrudging obedience. This discipline is true liberty and is the parent of Progress. Prejudice, long fostered by our insularity, by our class antagonisms, by our vested interests, and, above all, by our fossilized system of education, is the tyrant to be

destroyed. Progress struggling to free herself from the bonds of Prejudice and holding out her hands to the coming Dawn is the emblem of our national condition. The Dawn is hidden, but the Dawn is near.[1]

[1] See Frontispiece.

CHAPTER IV

WANTED—A NEW EDUCATION

GREAT BRITAIN'S Industrial Supremacy has gone—the way of all things which ignore the workings of the law of cause and effect. The effect has been seen in the preceding chapters and the glossary.

We now come to the root-cause. Let no one say—this is not the time for organic change. Never were the minds of our people more malleable, more free from prejudice, more open to conviction, and, therefore, more ready for movement in the cause of real reform.

No appeal will be made in this book to copy the educational pattern of any particular people or group of peoples. On the contrary, it is not only implicitly assumed, but stoutly held as a basic article of our faith, that no system imported from one country would or could suit the educational soil of another. For instance, there has been, in the judgment of the writers, far too much indiscriminate praise of German education. Indeed the acceptance of some of the methods of instruction—specially classical instruction—in vogue among that people, has done unqualified harm to all that is best in the English genius. It is hardly realized, for example, how greatly the meticulous examination of words and constructions in Greek and Latin, to the detriment of the study of the great thoughts embodied in the two languages, has infected whole generations of English students and teachers. Much of this has come

from the introduction and influence of German text-books and German scholars. The net result has been that three-quarters of the unfortunate victims of such instruction in our schools and colleges have grown up with a thorough disgust of this, and sometimes of any form of knowledge whatsoever; while many of the survivors from the wreck, so far from becoming wide thinkers, have been fossilized into philologists, and preserve an academic pedantry with regard to their outlook on life.

Again, German elementary education has, from the time of Frederick the Great, been regarded as a political engine which aims at reducing men to machines, "docile units of the State." Unfortunately, the system in vogue in that country of teaching the same subjects in the same way by means of uniform syllabuses to children in masses throughout the kingdom was for many years copied in our own elementary schools, with the result that all original thought was stifled in the pliable mind of youth.[1] Fortunately, on the other hand, the policy of instilling a militant patriotism instead of the civic virtues has never been followed in England. The result of that policy in Germany is what we see to-day.

Another unfortunate feature of English education in its highest grades is that the teachers have, until the last twenty years, come to their task almost entirely uninstructed in the science of their profession. The sole evidence of their fitness for instructing the choice youth of the nation has been the possession of some sort of degree at one of the Universities—a degree sometimes attained by showing in a written examination little more than a nodding acquaintance with the subjects in which they had

[1] *i.e.*, from 1862 to 1895.

themselves been instructed in youthful years. The degree, as the coping stone finishing off the edifice of a specialistic education, has been accepted as the symbol of educational power. Athletic eminence, of a University, or, still better, of an International standard, is regarded as amply compensating for any lowliness of the intellectual roofing.

Thus equipped (and many are, even now, not more efficiently trained) teachers have been let loose to lay their 'prentice hands on the raw material—which is none other than the flesh and blood, mind, soul, and spirit of the youth of the nation. Of the constituent parts of that delicate organism, how it should be treated, how it should be played upon, what external influences affect it, how it is best developed from within, or by what means stunted, strained, shrivelled—of none of these problems have they had until lately any real knowledge whatever. It rarely occurred to them, or to those who appointed them, that the laws of physiology, psychology, hygiene, and the like, had any connection with the efficient discharge of their functions. But all this has been treated more at length elsewhere.[1]

This astounding state of things is one of common knowledge among all who, like one of the writers, have passed a lifetime within the walls of Public Schools. It is only necessary to allude to the fact here in order to illustrate to the Man-in-the-Street the necessity of rebuilding the whole fabric of our educational system. The rest of this chapter will be devoted to an attempt to outline some of the biological principles which should be the basis of such an endeavour.

(*a*) The brain is the organ of mind. Any system of

[1] See *The Public Schools and the Empire*, by H. B. Gray, *passim*.

education to be successful must take into account the importance of training that organ, thus developing the living nervous substance of those parts of the cerebrum which are essentially necessary for the unfolding of our inherited intellectual faculties. The effective development of these centres is to a large extent under our control, for each one of them is in communication with our eyes, ears, or some other sensory organ. Thus by applying, especially during childhood, appropriate stimuli to the sensory organs, corresponding cerebral nerve cells are brought into action, and their molecular structure and functions can by exercise be modified.[1]

(*b*) The molecular structure of a child's brain is determined by heredity. The great function of education, therefore, is so to modify those inherited adjustments as to produce the best results. For it is through the medium of education that heredity, as regards both its good and its evil tendencies, yields to the formative influences of environment.

(*c*) The possibility of education depends upon the capacity of the organism to take advantage of its own experiences. The moth has no such power. It never learns through previous pains to shun the flame. Man has this power of learning to an extent beyond all other created things, not only through his own experiences, but through the experiences of the race. But, more than that, man not only *may*, but *must* be trained. The lower we go down the scale of creation, the more self-sufficient the organism is at its birth. In unicellular organisms

[1] The biological evidence on which the above statement is founded is given in a recently published work on *Instinct and Intelligence*, by N. C. Macnamara.

there is not much difference between the newly-born and the fully grown; but the higher up we go in the scale, the more helpless the creature is at birth. And this helplessness is at its maximum in Man. "Of all industries he is artless; of all institutions he is lawless; of all languages he is speechless; of all reasoning he is thoughtless; but arts, institutions, languages, reasonings he acquires as years go by from childhood to manhood." And this is none other than education. Education then, denied to all else, is the very life and breath of man.[1]

(*d*) Another biological principle which must have its place in any rational system of education is this—that the higher the type of the organism, the slower is the process towards maturity. Two corollaries seem to follow:—

(i) A certain kind of precocity at the period of pubescence may be evidence of a lower rather than a higher type of organism.

(ii) Any attempt to hasten the process of growth must result in permanent injury to the organism.

Both these corollaries have been ignored or defied by a large number of teachers, particularly in the higher ranks of the educational world. The competitive-scholarship system in vogue involves the choice of precocious boys at twelve to fourteen years of age; hence the danger of previous mental overstrain between eight and twelve, which biologists know to be a period of apparent stability, but of real delicacy. A money prize, therefore, which forms the bait of the (so-called) Public School, an indirect cause of profit to a certain type of Preparatory School, and a direct temptation to indigent parents, is

[1] See *The Educative Process*, by W. C. Bagley, chap. i.

nothing less than a dangerous gamble with immature life—a plucking of the fruit before it is ripe. Such a system indeed is responsible for thousands of lives being physically and mentally atrophied and ruined so far as regards ultimate success. It is small wonder then to hear of a certain proportion of candidates, successful at twelve to fourteen, beginning to drop off at fifteen, eighteen, twenty-one, and twenty-four, according to the comparative strength of their physical constitutions, and, after the age of thirty, being no more seen in the ranks of strenuous men. On the other hand it is a matter of common experience and remark that many who have been unsuccessful at school have risen to distinguished positions in after life.

What is the explanation of these disconcerting phenomena? The answer is not far to seek. Sometimes it may be traced to the self-interest of those trainers of youth who wilfully shut their eyes, and bid defiance, to physiological laws, but far more commonly it is due to the complete or partial ignorance of those laws on their part, and on the part of parents and educational authorities generally.[1]

(*e*) Another principle which needs emphasis in the attempt to found a rational system of education is the following: Extremely favourable and extremely unfavourable environments are alike obstacles to the mental, moral, and physical development of the young. Therefore, in settling the order of his life, and particularly of the subjects of his study, a careful watch ought to be kept over the instinctive movements and characteristics of the child considered in relation to heredity and environment. The cynical saying of the old pedagogue that "it does

[1] See *The Public Schools and the Empire*, chap. iv, pp. 63-8.

not much matter what you teach a boy so long as you make him hate it," is, of course, a deadly doctrine, which, however, seems to have taken possession so forcibly of some teachers that they have raised "three pages of the Latin irregular verbs" to almost the same level as the Apostles' Creed. On the other hand, the introduction of "soft options," which has done much to emasculate American education, is a hardly less fatal educational policy. Biologically, work as work, that is to say a struggle, but not a hopeless struggle, against environment should be a main factor in education.

(*f*) Finally the infant-man is (so to speak) protoplastic; that is to say, he reproduces in his own person in his progress from birth to maturity the evolution of the race. The savage, the patriarchal, the tribal stage, and the final emergence into a wider social life, seem all to be reflected in the movements, impulses, emotions, affections, and judgments of the gradually growing youth.

We now pass on to consider some more special aspects of a reformed education.

CHAPTER V[1]

THE ELEMENTARY AND THE TECHNICAL SCHOOLS[1]

Part I—The Elementary School.

IN the middle of the nineteenth century English statesmen awoke to the fact that it was a matter of urgent necessity to "educate our masters."

That many, specially among the Squirearchy, were found to doubt that necessity, and to scent danger to social order in conceding to their poorer brethren an opportunity of cultivating the best gift which God had bestowed on Man and which alone distinguishes him from the beasts, was perhaps only to be expected.

But it might provoke the surprise of a future historian to observe that statesmen of alert mind who recognized the silent claim of the people, and who shouldered the duty of meeting it, should have attempted to create an educational system without (apparently) any real knowledge of biological principles, such as have been outlined in the preceding chapter. Perhaps their own early unscientific training gave them no clue, nor had biological principles;

[1] The suggestions put forward in this and other educational chapters, so far from being intended to be exhaustive of the subjects with which they deal, or even to have any necessary interconnection, are meant rather to be provocative of thought, and to act as stimuli in driving home the need of a new and better order in our educational world. The final solution of this vast problem will only be found when the people of this country insist on that solution. One of the main objects of this book is *to create the consciousness of a need rather than to dogmatize on the methods to be applied.*

as applied to education, become at that date the subject of special study.

In 1861, the Royal Commission which was appointed to inquire into "the state of popular education in England," and into "the measures required for the extension of sound and cheap (*sic*) elementary instruction to all classes of the people," recommended, among other things, that a Grant should be paid to each elementary school, principally on the results of a yearly examination held by the Government Inspector on a syllabus issued by the Educational Department and binding on all schools alike. In other words "Examination" was to be the final cause, the test, and the aim, of all educational movements both for the teacher and for the pupil. Payment was to be by results; so many "passes" meant so many pounds, shillings, and pence into the school till. And the examination was to be on the basis of a syllabus, so graduated, so cut and dried, so defined and limited, that "a way-faring man, though a fool, should not err therein."

Every teacher was told exactly what to teach and what not to teach. The stream of knowledge was not to be a river bursting out here and there into newly discovered channels, but a canal with high confining banks hiding any wide intellectual landscape.[1]

This fatuous system lasted from 1862 to 1895, but the curse which followed in its wake long after it came to an end is still being felt. Many of the teachers of the present day have been trained under its blighting influence, and though

[1] One of H.M. Inspectors of Schools, in 1867, employed another simile: "Examination is to the Student what the target is to the Rifleman: there can be no definite aim, no real training without it." This astounding doctrine, which out-Herods Herod, led to the mental Massacre of hundreds of thousands of Innocents.

they are not now called upon to produce the kind of "results" demanded twenty years ago, it is difficult for them as instructors not to reproduce on the *vile corpus* of their pupils the methods of which they themselves were the victims in earlier years.

Happily, however, this does not form a true picture of the majority of teachers in the Elementary Schools to-day, who as a body are remarkably open to scientific influences. Indeed they are not infrequently far ahead of, though in many ways restricted by, the narrower views and red-tape methods of the Local and even of the Central Authorities.

We give an epitome of the consequences of such a system, which deserves record if only by way of warning against possible future lapses.

1. The aim being to pass as many pupils as possible, in order to secure the maximum grant, the work of the abler pupils was retarded for the sake of "weaker vessels," and "vain repetitions" were the rule.

2. The insistence on a syllabus choked variety, and had a tendency to turn out the pupils, like so many regimental buttons, all of one type.

3. Each subject was studied, not for its own sake, but for the purpose of catching the eye of the examiner.

4. But the worst feature of all, as viewed from the standpoint of the biological principles already set forth, was that the teacher did everything, the pupils nothing. The latter were the geese fattened for the Strasbourg Pie, on the "Open your mouth, and shut your eyes" principle. Nature has clearly indicated that self-evolution, self-expression, is the method of growth throughout the whole range of organic creation, Man included. But this system

prescribed that nothing was to be done without crutches from the Day of mental birth until the great Day of examination.

Enough has been said to show the disastrous result of the 1862-1895 programme on English Elementary Education. The beneficial changes which were made in the latter year are already bearing good fruit. The younger teachers, brought up on saner methods, and scientifically equipped for their educational work in Training Colleges, are succeeding their elders, who were the victims either as teachers or pupils of the now discredited system which ended in 1895.

Much more remains to be done. One bad blot still disfigures the existing methods of elementary, as indeed it still infects every stage and class of English education. The system of teaching and of enforcing discipline by excessive Prescription, still pervades the atmosphere of some Elementary Schools. It is not yet realized in a certain number of them that true education consists in the drawing out and unfolding of the capacities of the pupil. The proper function of the teacher is to supply nourishment, stimulus and guidance, but Prescription, whether by stuffing, or by restricting the free play of the faculties, crushes the self-evolution of the growing mind.[1]

Again—the methods of enforcing discipline call for criticism. There is doubtless an inherent difficulty in dealing with numbers such as are involved in the Elementary School system—a difficulty which Mr. Holmes in his inspiring book does not seem sufficiently to recognize—but at the same time it is an offence against Nature to drill a number of children as if they were mere automata,

[1] See *What is, and what might be*, by E. Holmes.

with regard to the exact attitude to be observed in addressing prayers to the Almighty, or in the identical movements to be used in reciting poetry, or casting up sums, or opening a copy-book. "Eyes closed"—"hands up"—"desks down"—"one, two, three"—and all the "do nots" are the petty rules which crush the opening life—rules which have no morality about them whatever, but are rules, simply to be observed for no other reason than because they are rules. Such a system is fatal to the evolution of character, and while a certain amount of mechanical discipline is indispensable, especially in town schools, it has been absurdly exaggerated.

Happily this prescriptive system does not obtain in Infant Schools, but is at its worst in the lower classes of Elementary Schools where the problem of large numbers has to be faced. The cure is to be found in the drastic reduction of numbers in each class. The next most effective way (after the reduction in numbers) in which the destruction of the old prescriptive system can be brought about is by a change in the main subjects of instruction. In other words, if the teaching of Science, for the younger classes in the form of Nature-study, and afterwards in elementary physics, chemistry, geography, etc., were made the foundation instead of the occasional feature of elementary education, the old instructional and disciplinary formulæ would automatically disappear. Science cannot, from its very nature, be altogether taught by magisterial information, but rather by setting the young mind to work upon itself and to employ its native powers of observation and perception. Moreover it involves individual, and not collective and mechanical attention. The subject matter of Science depends not

on past information but on future attainment—it looks forward from the known to the unknown. Thus gradually stimulus would take the place of prescription, and guided self-expression would displace the meaningless dictates of authority.

If our Central and Local Educational Authorities, and those who teach the teachers, could all be brought to realize that the work of Elementary Schools is not merely to impart instruction to the mass, but to foster individual intelligence and individual character, they would be laying the foundation of an ideal education for the people at large. The solution of the problem is, beyond all else, the establishment of smaller classes.

The great mass of teachers quite realize the nobility of their calling. During the war they have shown themselves to be men of remarkably high ideals. Their patriotism, both in personal example and in stimulating their old pupils to take active service in the field, has been most marked.

Part II—The Continuation and the Technical Schools.

An indispensable condition in any scheme which undertakes to secure an ideal education for the industrial classes in England is this :—there must be a compulsory extension of the age at which the boy or girl is at present allowed to drop all educational training and to plunge into his or her life-work without any further supervision or guidance. The State has already admitted the necessity of providing for the moral and mental welfare of children up to the age of fourteen. In her own interests she should extend that supervision for at least three to four years

longer; otherwise most of the funds she has expended remain unproductive, and she is exposed to danger from half-educated rulers. It has been calculated that at present 1,500,000 boys and girls from fourteen to seventeen are receiving no education of any kind. A scheme which provides for such education would involve at the outset a large national expenditure, but would be an investment of incalculable value.

Boy-labour from the ages of fourteen to eighteen as a source of unemployment has been reported upon lately by a Royal Commission on "The Poor Laws and the Relief of Distress." The following paragraph from the *Economic Review* expresses the difficulty that has to be faced:

"It has been universally agreed that the problem is largely caused by young people leaving school at the age of fourteen with a limited amount of education, and taking up blind-alley occupations which offer them a relatively high commencing wage, but a minimum of industrial training, and leave them at seventeen or eighteen a 'drug in the market,' incapable, and impossible to absorb, except perhaps at times of unusual trade prosperity."[1] Mr. Arnold Freeman in his book on *Boy life and Labour*, has made an exhaustive practical inquiry into this matter, and has shown by analyzing seventy-one cases how serious is the wastage of early promise caused by the boy being plunged prematurely

[1] See *The Economic Review*, of January, 1911, quoted by Mr. Arnold Freeman. It may be added that boy employment, stimulated as it has been by the abnormal conditions arising out of the war, may render the problem more acute. Ease in earning high wages, without corresponding ability or service, brings grave moral consequences in its train.

into life without guidance and instruction. He shows conclusively that "the hours of juvenile toil are so long as to make it impossible or difficult for the boy to continue his education in his so-called 'leisure hours,' and that the effect is to drive him into contact with undesirable social influences which tend to demoralize him."

The remedies proposed by Mr. Freeman are:

1. The statutory reduction of the hours of juvenile labour.
2. Compulsory continued education.

The Compulsory Continuation School is an absolutely essential item in the programme of a future education, if our industrial efficiency is to be superior to that of our foreign competitors. For not only must our machinery be the best of *its* kind, but the "Man behind the Machine" must be the best of *his* kind. Thus only can the work of production be organized on the highest lines of efficiency, that is to say, with a minimum of waste of material and energy.

How can this compulsory education be continued with the greatest economy, *i.e.*, with the greatest gain to the State?

It is admitted that the old and valuable system of apprenticeship, which in earlier days did so much to develop the best traditions of trade, cannot be generally revived owing to specialization in every branch of industry. On the other hand the optional Evening Schools have shown themselves far from successful, for the pupil who has been at work all day brings to them a tired brain. Attendance at Continuation Schools during daytime, coupled of course with a drastic reduction of working hours,

should therefore be made compulsory for all boys up to the age of eighteen. The State must provide large grants for this purpose in a bountiful spirit.

The objection naturally arises — this compulsorily continued education will reduce gravely the supply of labour. How is this shortage to be met? The solution of the problem may be found in some such scheme as has been adopted and successfully carried out at the York School of Pennsylvania, U.S.A. It is there called "the Co-operative Industrial Course," and was inspired by a similar scheme in vogue at the University of Cincinnati. The Co-operative Course is briefly as follows. It extends over a period of four years. The first year (fourteen to fifteen) is spent wholly in the Trade or Continuation School, and the course of instruction is so arranged that the boy can specialize in those subjects which will best fit him to take up his trade in the shop. The next three years (fifteen to eighteen) are devoted partly to school and partly to shop work. During the time that the Schools are in session, each boy attends every alternate week. The remainder of the weeks in the year are spent in the Shop. But—and here comes in the special point of the scheme—the boys are *paired* in each trade, so that while A is in school, B, his mate, is in the shop, and vice versa.

This scheme is in effect a half-time apprenticeship, without, however, the principal difficulties which attend the work of a single boy working half-time, *i.e.*, for so many hours a day, or for so many days a week. The work of the two paired boys has been proved by experience to be at least equivalent, as regards value of output, to that of the single boy working full time.

Anyhow, whatever system be in vogue, there must be a more intimate touch between Junior Technical Schools and prospective employers. This might be secured by advisory bodies, consisting of employers and employees who are connected with the occupations for which each school furnishes a preparation.

Technical training throughout the country has, for various reasons, somewhat languished during the last few years, though there has been a recent revival. There are fifty schools now recognized for instruction in Engineering, Building Trades, Woodwork, Printing, Book-binding, and Silversmiths' work. Yet what has been done is not a tithe of what is required. Government must act, and that quickly.

Some of the Higher Elementary Schools have their manual training, and an engineering side as well as a commercial side. Such a combined education would be valuable in the case of those who are afterwards employed as salesmen and commercial travellers, while those who are destined for the counting-house might follow the more purely commercial course. In the Junior Technical Schools, which should cover the whole face of the country, the course of studies should be of a general character, including mathematics, English, geography, history, science, and drawing, together with practical laboratory and manual training work.

In the sphere of Secondary Education a large number of Higher Technical Schools for boys entering the various trades should be created. Attendance at these might be organized on the Cincinnati system, while higher commercial training might similarly be carried on for boys (and girls) intended for Commerce, in those existing

Secondary Schools which are managed by the County Councils, and in the Grammar Schools.

"It is astounding," says Professor Ripper of Sheffield, "that though Britain is so great as an industrial nation and depends so much as she does for her future upon the skill and efficiency of her industrial workers, there is practically no organized and well-thought-out plan for the training of those upon whose ability and skill the future industrial well-being of our nation depends. Our young people are not taught their trades; they pick them up as best they can."

"It is beyond doubt," says Mr. Charles Hobson, the Sheffield labour-leader, "that whatever advantage Continental nations have had, either in methods of production or in their mode of training, over the British, their success is mainly the result of having a better system of technical education, specially directed to the teaching of trade, coupled with a better system of apprenticeship or indenture, and compulsory attendance at school during the apprenticeship period, the sole purpose being to teach a trade thoroughly, including its organization in production and distribution of manufacture."[1]

Germany, for instance, which has neither the deposits of coal which have made England rich, nor the wonderful soil of America, yet, principally on account of her highly organized technical education, has been able in seventeen years (1897-1914) to increase her industrial production sevenfold. At Charlottenburg and other Technical High Schools more than 12,000 students are trained, a large

[1] See his book *The Teaching of Trades in Continental Countries.* This pronouncement is specially striking, as it shows how closely interested the Trade Unions are in demanding efficient labour, and objecting to "unemployables."

percentage of whom are foreigners. In Munich, which is the model city for the study of the continuation school problem, every boy after leaving his elementary school at the age of fourteen is compelled to attend a continuation school of a "trade" character unless he is already at one of the higher schools which prepare for the Universities and the official and learned professions. There are in that city schools for every trade which can provide more than twenty pupils between the ages of fourteen and eighteen. The schools are free: half the cost of maintaining them is borne by the State and half by the city.

There are fifty-six of these schools for a population of 600,000.[1]

The academic school-teachers co-operate with foremen, artisans, and agriculturists. The subjects taught are trade-arithmetic, book-keeping, business-composition, citizenship, information about the special trade, goods and tools in use, drawing, and finally practical work. For such trades as require it, physics and chemistry are everywhere included. There are separate schools for Mechanics, Stokers, Shoemakers, Printers, Gardeners, etc. Germany, in fact, though in many respects inferior to England in her elementary and secondary education as far as regards the training of individual character, yet vastly excels us in the development of her technical education. She possesses, in fact, what we lack, here as everywhere—the spirit of organization.

If the German system were so modified as to meet our national requirements—if, for instance, it were adapted to the Cincinnati programme, which combines the advan-

[1] For an extended study of this subject see *The Problem of the Continuation School*, by Best and Ogden.

tages of academic training with practical experience in "works" and the payment of wages for half-time labour, the economic gain to English trade would be enormous, and magnificent results would be visible in increased output in far less than a decade. But, more than this, the inventive genius of the English mind, now stifled through want of scientific training in early years, would have free play, and would contribute to regain for England her lost supremacy as "The Workshop of the World."

CHAPTER VI

THE PREPARATORY, THE PUBLIC, AND THE SECONDARY SCHOOLS

"THIS is an age of modern artillery, and we turn out boys to do battle with it equipped with the sword and shield of an ancient gladiator"—the scathing indictment of Professor Huxley against English Secondary Education more than forty years ago. Have we brought our educational weapons up to date since then? This is the question which this and the following chapter seek to answer with a view to reform.

Any attempt to unify English Education is beset with a difficulty of a twofold character—the one social, the other more strictly educational.

1. Socially—the gulf between the Elementary and the Preparatory Schools and (to a less degree) between the Secondary and the (so-called) Public Schools is so wide that up to the present time they have practically formed two distinct educational worlds.[1]

The Elementary Schools of England, evolved as they were out of the old Charity Schools, were born with the pauper stigma upon them. Although this stigma has now disappeared, the gulf remains unbridged. In the sphere of Secondary Education the gulf between the classes has tended rather to widen than to disappear. In

[1] The Public School is technically a Non-Local Secondary School, but the term is here used in its popularly accepted sense. It is, of course, a misnomer. See *The Public Schools and the Empire*, chap. ii, pp. 27-38.

pre-railroad days, the son of the county magnate sat on the same bench in his County School with the son of the local tradesman. But increased means of communication has killed the prestige of the old Grammar Schools by making it easy for the boys of wealthier parents to travel to distant fashionable academies, old and new, preparatory and public.

2. Educationally—the Elementary School holds out as its ideal (however imperfectly at present achieved) the evolution of the mind of the pupil. The Preparatory School on the other hand, while it professes and doubtless desires a like evolutionary aim, is in fact controlled, so far as regards the nature of the studies pursued, by the Public Schools and Secondary Schools for which it acts as the nursery, while the curricula of the Public and Secondary Schools are in their turn dominated, directly or indirectly, by the educational demands made upon them by the two ancient Universities. These demands are made effective in three ways :—

(*a*) By the subjects prescribed for entrance.

(*b*) By money-prizes in the form of scholarships, etc.

(*c*) By the Oxford and Cambridge Local Examinations.

The objection which may be taken to this statement, in the light of the fact that only four or five boys out of every hundred proceed from the average Seconday School to the Universities of Oxford and Cambridge, has been dealt with at considerable length elsewhere by one of the writers.[1]

[1] *The Public Schools and the Empire*, chaps. v, vi, xvii, and particularly chap. xv, and the footnote on p. 241.

These things being so, it might have been expected by anyone versed in logic, but unacquainted with the inveterate policy of English Governments to follow the line of least resistance, that in any attempt to introduce a national educational programme, or to produce some sort of cosmos out of chaos, a beginning in reform would have been made with the two Universities. But such a thinker would have failed to take into acccount the power both of the vested interests of the living and of the " dead hand " of the past. Moreover, the Universities, or rather the Colleges of which they are the central shrine, have been the bestowers and not the recipients of bounty, and that fact, in the eyes of the State, has been a valid reason for leaving them alone. The student of *English* parliamentary policy, therefore, notes without surprise that, while even the Public Schools have, under various pretexts (such as sanitary regulations, etc.), been deftly drawn into the net of the State-Inspector, it has required an Empire-shaking War, revealing the disastrous effects of an unscientific education on rulers and ruled alike, to bring into the region of practical politics the possibility of appointing a Royal Commission to include in its survey the ancient Universities. To sum up—the social gulf between the Elementary and the Preparatory Schools seems impassable, and the building of any bridge a far-off ideal. But an approximation between them as regards subjects of study would narrow the gulf at a later educational stage.

The Preparatory School.

After this preliminary survey, we proceed to deal briefly with the Preparatory Schools, anticipating the time when

they will be no longer dominated by the pressure of an antiquated curriculum now forced upon them by the Public Schools. But, lest we should be suspected of being tainted with the heresy that exclusive training in the natural sciences is the only passport to entrance into a successful manhood, it is desirable to formulate here our main educational principle. *Due balance must be maintained between naturalistic studies on the one hand and literary studies on the other in the education of all boys up to a certain limit of age*—which limit should vary in accordance with the age at which they are destined to end their school life altogether. This position will be developed later on, but a statement of it here will pave the way towards a clear understanding as to the subjects which in our opinion should be taught in Preparatory Schools.

These subjects may be summed up as follows:

(*a*) English, to include reading aloud (with just emphasis and elocution) of simple literature.

(*b*) History grouped around lives and characters.

(*c*) Arithmetic with mensuration.

(*d*) The elements of mechanics.

(*e*) Nature study on a gradually expanding scale from local to national environments.

(*f*) Geography on a modern and scientific basis.

(*g*) One modern language which, for reasons dealt with elsewhere, should be French.

(*h*) Drawing—Freehand.

(*i*) Manual training, which, as in the Public Schools, should be taught to all boys as part of the curriculum for one-third of the weekly periods now spent in non-productive games, such games to be limited to three

afternoons a week; while one afternoon at least should be devoted to physical training.

There should be some real inspection of every educational establishment which professes to train the body and mind of young citizens. Every such establishment should not only be recognized but licensed, and the same rule which safeguards the public from those charlatans who profess to cure bodily ills should be exercised in the sphere of education. No such licence would be issued to a headmaster unless he could show some knowledge of leading physiological and psychological principles gained in a training College or at a University. This need not at all involve a prescribed uniformity in the methods of training. It would be quite possible for the State to allow a wide variety of method—a variety indeed which has been the chief virtue (in spite of all its defects) of all stages of English education for the prosperous classes. But unlicensed practitioners must be crushed by the registration of all teachers, and by licensing, after inspection, the schools which they control. This need not check the free accumulation of profits by those schoolmasters whose personality and ability bring them into favour with parents, but it would have the effect of safeguarding the State against the inadequate training of its citizens.

The Public and the Secondary Schools.

To pass on from the Preparatory to the Public and Secondary Schools. The subject is too vast and ramifying for us to do more than indicate briefly the various reforms which seem needed in Secondary Education in England. The arguments which go to support the positions taken up in

this chapter may be found discussed at length in the book already quoted.[1] A clear distinction must be drawn between:

(*a*) The (so-called) Public School where the general leaving age ranges from seventeen to nineteen; and

(*b*) the ordinary Secondary School, whether Grammar, Municipal, or County, where it ranges from fifteen to sixteen.

For, however illogical this distinction may appear to one unversed in the subtleties of our social and educational systems, the difference between the two is and will continue to be a real one, involving somewhat different problems and therefore somewhat different treatment.

(*a*) *The Public School.*

1. The pupil admitted to the Public School would not, according to our creed, have been pressed mentally during the age of *apparent* stability but *real* delicacy (eight to twelve), or during the years in which pubescence begins (say thirteen to fourteen). But it may be said in passing that for the large majority of boys it would be more desirable on physiological grounds if public school life were to begin a year earlier than is at present usually the custom, *i.e.*, at twelve-thirteen instead of thirteen-fourteen.

2. Scholarships, if awarded on entrance, should be granted on financial grounds exclusively, provided that a moderate standard of knowledge and intelligence were attained. This standard would involve little beyond an elementary (and chiefly *viva voce*) examination. But

[1] *The Public Schools and the Empire, passim.*

competition should be eschewed, and to meet the difficulty of applicants being in excess of vacancies, the value of each scholarship might be reduced. No boys who are the sons of wealthy parents should be admitted as candidates. Examinations, as instruments of education, should be reduced to a minimum up to the age of seventeen.

3. There should be no water-tight compartments inside a Public School such as now exist in one or two of the oldest Foundations for the segregation of the abler boys. This is a fundamental offence against the rest of the school, and moreover an offence against citizenship. Intellectual leaven, where it exists, should permeate the whole society. The temptation of the prosperous parent of a boy of superior intelligence to put him to "herd with his intellectual equals" has been responsible for many abuses. Such a desire has often induced wealthy or well-known men to accept eleemosynary favours.

4. The educational curriculum for all boys from the beginning of Public School life, *i.e.*, at twelve years of age, ought to be conducted on the Grand-Trunk principle. Any hard and fast line of demarcation, such as is sometimes drawn at the beginning of a boy's school career between the Classical and the Modern Side, rests on no scientific principle, and is injurious to balanced intellectual growth. Specialization at the age of thirteen to fourteen is an educational error in the case of those boys whose school life will extend to seventeen or eighteen. The argument sometimes brought forward that, because the ablest boys are to be found on the Classical side, the cult of Latin and Greek is proved thereby to produce a more refined and powerful intelligence, will not bear examination. Obviously, the bribe of University Scholarships, heavily weighted on

the Classical side; tempts the parent of a promising boy to enter him on that side.

5. Science—that is "the ascertained facts and principles of mechanics, chemistry, physics, biology, geography, and geology"—should no longer be regarded as the fifth but the first wheel of the educational coach. For that purpose it should displace the old classical curriculum in the ordinary boy's education. An alternative course would be allowed after the age of fourteen for boys who aspire to enter such professions as the Church, the Law, and Medicine. Such a course would include Latin and a Modern Language, or alternatively, Latin and Greek. But for the Naval and Military Services the ancient languages should completely disappear. As part of the training for the Civil Service, Latin should form an alternative, and equally weighted, optional course with Advanced Science.

6. The teaching of the classics as a training for the professions named above should be organically reformed. The tyranny of the Grammars must be overthrown. By the wearisome insistence on grammatical study linguistic progress is retarded. "A very small percentage of boys studying the ancient languages ever arrive at such a stage of progress as to imbibe any sort of intellectual advantage from the great thoughts of the master minds of Greece and Rome."[1]

7. French, taught orally and practically, and also with due regard to the literature, should be continued from the Preparatory School stage throughout the whole of Public School life. The intrinsic genius of that language for clarity of expression, as well as the fact that it is the tongue of those who are most allied to us by geographical and

[1] *The Public Schools and the Empire*, chap. ix, pp. 154.

political conditions, make its acquisition an indispensable item in the educational programme of every cultured man.[1]

8. Mathematics, studied with a view to their commercial utility as well as to their applicability to scientific pursuits, must be, of course, incorporated in the general curriculum.

9. The study of Geography has already been insisted on. It need only be added that it must be pursued on a scientific basis and in due connection with history and economics.

10. Drawing, both freehand and geometrical, should be included in the curriculum.

11. Last, but not least, English must take the chief place (together with Science) long usurped by the two Ancient Languages in the general education of all boys up to the age of sixteen. Its study should be divided into two parts:

(*a*) Literature.
(*b*) Composition.

A word may be said on both.

(*a*) English hitherto, like the ancient classics, has suffered from its own votaries. "Of making of books," to be foisted upon the educational public, "there has been no end"—especially if they have been cheap. Any little dry-as-dust sciolist in English, or Greek, or Latin, has thought it a help to his professional career "to bring out notes." Hence the great classics of English prose and verse have fallen into disrepute. Unhappily, the curse of competition and the necessity to give the boy "something to prepare" have accentuated the evil. Notes have

[1] *Studies in Foreign Education*, by Mr. Cloudesley Brereton, p. 288.

been studied merely for the sake of the "preparation." The boy has to swallow a pennyworth of bread and an intolerable deal of sack at the same time.

Elocution—a branch of education once fruitfully practised in an age when hand-books were few, but now almost killed (except on Speech Days) by disuse—should be revived. The function of the master should be to guide the pupil to read for himself, to repeat aloud passages from the great authors, and to paraphrase their thoughts and make them his own, so that after a period of sub-consciousness they may be reproduced. Learning by heart should be encouraged, but only after the subject matter is understood. The best literature of Greece and Rome should be read by all boys in the many admirable translations which exist, both for its own sake and as the source of inspiration for the great English classics.

(*b*) With regard to composition, one of the writers came to the conclusion during a long period of rule over a Public School that the most testing and the most reproductive work in English, or indeed in any branch of study, was an extensive practice in précis writing.

Original composition should also be attempted from an early stage, so that facility of expression both by tongue and pen may be thereby acquired. The lack of power in speech-making, which is observable among Englishmen and not least among English "Academics," seems to arise partly from the fact that the student has not been accustomed to any other mental connection than that between eye and book. The tripartite employment of tongue, eye and mind, from the practice of reading aloud, and of re-casting other men's thoughts in the native tongue, would be of direct value to citizenship.

12. This leads to the question of Examinations, the multiplicity of which is probably the greatest curse of English Education which exists to-day. Here we should do well to follow French rather than German methods. The internal examinations in France are not squeezed into a last fortnight, but "compositions" are separated from each other by at least the period of a week.[1] Moreover, instead of a mass of questions to be answered within an inconceivable minimum of time, three or four questions alone are asked. This method gives the fullest scope for the style in which the information is to be expressed, and not for an undigested mass of information rapidly reproduced.

Again—oral examinations, which, for reasons already hinted at, have fallen into disfavour, should be re-established in all stages of education.

External examinations have proved the greatest bugbear of all. They have, indeed, so dominated education that knowledge has become the parasite of examinations rather than examinations the bloom on the fruit of knowledge. For this pest the system which works with admirable results in the Middle East in the United States might be largely substituted—that is to say, the system of "accredited" schools. According to this plan, students, on the recommendation of the headmaster of an "accredited" school or of a committee over which he presides, are admitted to higher places of education, and also as probationary members of various professional and trade bodies.

It will be seen from the foregoing that, according to the

[1] *Studies in Foreign Education*, by Mr. Cloudesley Brereton, pp. 283-5.

curricula proposed, a boy going to a Public School would be able to avoid taking up Latin and Greek entirely—an escape which is hardly possible at most Public Schools under the prevailing system, and practically impossible at those Preparatory Schools which are dominated by the Public Schools. In France and Germany such an escape is always provided in the educational scheme.

(*b*) *The Secondary School.*

The main educational principles which have been already set forth in the treatment of the Public Schools apply *mutatis mutandis* to the Secondary Schools, *i.e.*, the Grammar, the Municipal, and the County Schools. But the age at which specialization should begin must perforce be modified to accord with the general leaving age (fifteen to sixteen) of boys attending this class of schools. While, therefore, the general principles underlying the suggested reforms numbered 4-11 would hold good, alternative courses of:—

(i) English, French, Science and Mathematics;
(ii) English, French, one other Modern Language, and Commercial Mathematics

should begin for boys who have arrived at the age of thirteen and a half or fourteen. But it should be understood that a certain knowledge of Science would, according to our scheme, have previously been attained by boys who adopt course (ii).

CHAPTER VII

THE PUBLIC SCHOOLS (*continued*) AND THE UNIVERSITIES

Part I—The Public School.

AFTER the age of sixteen, specialization would begin for the Public School boy, as follows :—

(*a*) Literary.

(*b*)—i. Commercial ;

ii. Scientific.

(*a*) On the Literary side, one or both ancient languages should be studied on the reformed method, where grammar is subordinated to the literature. Ancient and Modern history should be read in conjunction with such a course, while mathematics and science might be dropped ; but geography should be studied in close connection with history and economics, which last should also form part of the classical curriculum.

(*b*)—*i.* On the Commercial side, one other modern language should be combined with French—either Spanish, or German, or Russian, or Italian—according to the career which the pupil is likely to enter. The principles of business should also be studied, including accountancy, banking, etc. Mathematics of a commercial character should be emphasized.

ii. On the Scientific side, one or two special branches of science should be pursued, adapted to the future career of the pupil, since by the age of sixteen to seventeen the destinies of most boys will have been determined.

Applied mathematics should be studied, and geography and geology should always be included in the curriculum.[1]

Finally, the principles of biology should be the subject of study for all boys over sixteen, whether on the Literary, the Commercial, or the Scientific side. To the small minority who afterwards enter the teaching profession an intimate knowledge of that science is indispensable.

It will be noticed that in the foregoing suggested curricula a reduction in the number of subjects to be taught is one of the aims of a reformed Secondary Education. English schools have suffered for some time past from the multiplicity of subjects studied—a multiplicity forced upon them by the wide variety in external examinations.

Finally—there should be a graduated system of manual training for all boys in Public and Secondary Schools. The connection between mind, eye, and hand, has never been sufficiently emphasized by the average English schoolmaster. Possibly the aristocratic prejudice against manual labour has had something to do with this serious defect in English education. But prejudice of such a kind has, it is to be hoped, now died. Manual training should, as at the Preparatory School, take up at least one-third of the hours now devoted to non-productive games. These latter, admirable as they are for the inculcation of esprit de corps, have suffered from the abuse of their using. "All day and every day" games-madness has led not to efficiency but to inefficiency in sterner fields. Another one-third of the leisure hours should be devoted to military

[1] Any detailed reference to religious instruction would be out of place in these pages. The whole atmosphere of Public and Secondary Schools is presumed to be pervaded by religious teaching.

drill, the importance of which scientific warfare has brought vividly home to every citizen as the necessary condition of his future liberty.

It is impossible here to meet by anticipation the criticisms to which the presentation of the reforms sketched may give rise. The reader will find many of these criticisms answered in the book to which reference has already been made in these pages.[1]

Nor is there space to discuss in detail the character-forming influences supplied by the Boarding and the Day Secondary Schools respectively. But it may be desirable to rebut the charge that the disappearance of the two ancient languages as the mainstay of the Public School curriculum will produce an unwholesome effect on the character of those who have been relieved of that burden.

In the judgment of one of the writers who has passed almost a lifetime in Public Schools,[2] it is not in the kind of subjects studied, but in the nature of the corporate life led, that such character-forming influences find scope for their full and permanent effect. The self-reliance of Public School boys as a set-off against their tendency to conform to type, their intense but somewhat narrow camaraderie which has hitherto shown little sympathy with classes other than their own, their worship of physical prowess and their comparative contempt for mental superiority, their capacity for rule over lower grades of civilization than themselves—all these cannot fairly be ascribed to the influence of any particular subjects which

[1] *The Public Schools and the Empire, passim.*

[2] As a boy at Winchester, as an assistant master at Westminster, and as headmaster for thirty years at Bradfield.

they may happen to have studied. This much only may be predicated with regard to the influence over character caused by the different subjects of instruction. A literary education would tend rather to breed a reverence for prescription and authority, while a scientific education would serve to produce a greater independence of character. The classicist would gain an advantage in style and expression, but that advantage would be counterbalanced by the greater receptivity to new ideas fostered by the study of the natural sciences.

The mental training of the Public School boy, especially one who is to take his share in the ruling of a world-wide empire, should, as Matthew Arnold said long ago, be distributed up to a certain age (which we have fixed at sixteen) if not in equal, at least in not totally disproportionate parts, between the pursuit of naturalistic and of humanistic knowledge—between the study of (1) nature and her work (2) man and his work.

Part II—The University.

In the ascent of the ladder from the Secondary School to the University, we are confronted more vividly than ever with the total lack of organization which at present marks English Education. There has been an immense growth in the twentieth century in the number of new Universities. In England alone, which for hundreds of years had been content with two, no less than five have been founded during the first decade of the twentieth century, besides those which sprang into life between 1830 and 1900. But these new institutions, which owed their foundation to, and were fostered by, the great centres of

industry are entirely out of touch with the ancient foundations. Theoretically their ideals are the same; practically their functions are widely different.

What should be the ideals of a University? They may be summed up in the words of Lord Rosebery in his opening address to the Imperial Congress of Universities in 1912:

1. The work of research.
2. The training of higher intelligences.
3. The training of the average student for the business of life.

On the principle of *Seniores Priores*, we address ourselves first to the question how far the ancient Universities have hitherto discharged this threefold function. Or rather, since for the purpose in hand the first and second of Lord Rosebery's ideals may be merged into one:

(*a*) How far have they forwarded research as applied to the business of life?

(*b*) How far have they trained the average citizen for the successful conduct of that business?

Let us consider the latter question first. We have already seen that the ancient Universities have directly or indirectly dominated the subjects of instruction in vogue in the Public and Secondary Schools of England. But it is admitted by unprejudiced thinkers that the nature of the education given at Oxford and Cambridge, though not ill adapted to the profession of the lawyer, the clergyman, and possibly the doctor, cannot be regarded as helpful to the efficient conduct of many other avocations open to the English citizen—of the Civil and Military Services, and of all the variously ramified departments of industry and commerce.

1. The insistence on the necessity of a knowledge of two dead languages as the condition of entrance is, in the eyes of the educational reformer, self-condemnatory.

2. The mental attitude which regards the contemplation of the past as the main aim of education—we say emphatically, the *main* aim—is but ill-suited to the training of men whose business is to look to and provide for the future. The continual dwelling on precedent, whether in the academies or in the professions, tends to unfit a man for leadership and enterprise. Knowledge is only power if it be applied knowledge, while, with regard to the facility of expression, which the exclusive study of the humanities sometimes (but not always) develops, it may be well to remind ourselves of Bacon's epigram that "it is not so important to know what might be said as what ought to be done"—in the business of life.

The curricula at the two ancient Universities, especially at Cambridge, after the entrance bar has been successfully negotiated, have, chiefly owing to outside and inside pressure, been considerably widened since the opening of the twentieth century. But still the fact remains true that there is no close touch between the old-established academic courses and the business of life. There is no course, for instance, adapted for a commercial or industrial career. War has made sad havoc in the ranks of Oxford and Cambridge students. If these Universities, with their glorious though somewhat chequered history, are to keep their place in the forefront of English education, they must adapt themselves to the requirements of a great Industrial Empire, either by means of reform within, or by a Commission from without. Otherwise they will be left in a backwater in the stream of progress.

It would be unfair, however, to leave the Man-in-the-Street, who has probably little knowledge of University policy, with the impression that the resident authorities are the foes of reform. The very contrary is the case. It is the non-residents, *i.e.*, clergymen, schoolmasters, and other old students, who bar the way. Therefore, the first and most obvious step in reform would be to abolish the voting-power of Convocation and Senate as at present constituted.

This leads to the consideration of the other problem. How far are they fulfilling their function of carrying out research with a view to industrial developments? A statute making the pursuance of research obligatory on candidates for Honours in chemistry at Oxford is doubtless a step towards this end. The research work at Cambridge is excellent, though it is at present limited in scope. But for the purpose of raising a great army of scientific workers indispensable for success in the industrial war with Germany after the present conflict, we shall have to look to the new Universities for some time to come. To these we now proceed.

A reference to the Glossary will show the amazing poverty of production in the United Kingdom, as revealed by the Census of Production. One remedy for this can be secured by a closer touch between the new Universities, the Technical Schools, and the Factories. This means that there must be an endowment of industrial Research-Studentships, such for instance as are established in the Universities of Pittsburg and Kansas in the United States. Failing help from the State, manufacturers whose business

is concerned with scientific processes might enter into contract with Universities and Technical Schools to pay selected Students or Fellows a stipend for the exclusive use of their services for a definite period, with a bonus if their researches resulted in success. The Student or Fellow on his part would bind himself by contract to secrecy. In this way the manufacturer would obtain command of the resources of University laboratories, while the investigator would be rewarded not only by stipend but also by an increased reputation. The University meanwhile would gain valuable contributions to its scientific knowledge as the indirect outcome of the solution of commercial problems. Such a system would be preferred by many to that of the establishment of national laboratories, as is suggested in another chapter of this book,[1] since it would avoid the necessity of putting research into the hands of a bureaucracy—a method which is not regarded in some quarters as likely to be productive of happy results. Possibly a combination of the two plans would prove a good solution. A third plan, which has for some years past been successfully adopted in the United States, would be to allow or compel a University professor to carry on, as a consultant, a certain amount of practical outside work.

Up to the outbreak of the war there was no bridge between the University and the Manufactory. The professor never or rarely came into contact with the manufacturer. He did not always realize that his scientific knowledge could and should be reproductive, while the manufacturer, *having been seldom educated in scientific knowledge in the days of his boyhood,* relied

[1] See chap. xi, p. 102.

mainly on antiquated methods, and sometimes regarded the academic professor as a product of fossilized humanity.

It cannot be too often insisted on that the British brain is naturally more inventive than that of other races; but as things are, while fundamental discoveries have frequently been made in England, their practical application to industrial and commercial processes has generally been worked out in foreign countries.[1]

Before these educational chapters are brought to a close, it is desirable to make certain general observations. First of all, a clear distinction must be made, both in principle and practice, between actual instruction in science on the one hand, and the inculcation of a scientific habit of mind on the other. The latter implies a *method* of education which has been notoriously lacking in the past. Though, therefore, all the youth of both sexes in future generations, from the highest to the lowest, should receive some instruction in the natural sciences, yet expert knowledge in any one of their many branches will always be reserved for those whose future occupation demands such a specialistic course.

Secondly, the apparatus for teaching science in all grades of schools must be largely supplemented by the educational authorities. Nature study and hygiene, which are already taught in the lower classes of elementary schools, should be extended and systematized, though little pecuniary aid is needed here. In the upper classes, a connected course in chemistry, physics, and mechanics should be organized, and this necessitates a more generous provision of funds. The course should deal with the application of science to

[1] See the Glossary, *passim*.

modern life, *e.g.*, " the application of electricity to transport, lighting and heating, mechanics in air-craft, the coal-tar industry, utilization of water-power, the dependence of the nation in war and peace on chemistry and engineering, the means of discovering adulteration of food, the use of lenses, &c."[1] Since the teaching of science involves comparatively expensive apparatus, a liberal bounty ought to be bestowed by the State on Non-Local Schools, and by the local Educational Authorities on Local Schools.

Thirdly, the allocation of the majority (in number and value) of Scholarships and Exhibitions in the two ancient Universities for proficiency in Latin and Greek must be swept away, and a larger proportion awarded to proficiency in scientific subjects. An eleemosynary test should in all cases be enforced. Such a test would be nothing more than a restoration to the necessitous of what was originally intended by the founders to belong to them. The endowments of the colleges should be pooled, and the machinery of the Universities as a whole organized, by a part application of such funds.

Finally, it is only through the inculcation of scientific subjects duly graded throughout all stages of education that a silent revolution can be effected in the thoughts and outlook of the people at large. " The necessity is for a more widespread distribution of scientific knowledge, not so much amongst scientific workers, as among the general public and Civil Servants... Let us retain a strictly scientific course of training for the youth who is to make science his profession, but let us also see that the public shall have a

[1] See *The Teachers' Times*, of March 10th, 1916.

general knowledge of the phenomena of Nature and of the more important manufacturing processes."[1]

It is indeed of vital importance to the future of Great Britain that her sons should be scientifically instructed in the days of their youth, so that, whether they become in after years leaders of the people, or captains of commerce, or industrial workers, they should know thoroughly the scientific laws which govern the economic production and distribution of the fruits of the earth.

Having thus pleaded the urgency of a drastic reform in our national education, the writers will attempt in the following chapters to present a new conception of Business and Empire.

[1] Extract from a recent address by Dr. Garnett to journalists.

PART II

CHAPTER VIII

SOME IDEALS OF BUSINESS

MAN was born to be a creator. In so far as he fulfils that mission he earns the crown of manhood; in so far as he shirks it, he becomes a drone in the human hive, a "tramp," a useless burden on the earth.

It is on Business as the raw material for the hand of Man the creator that we would in this chapter attempt to fix our eyes. Business is the efficient conduct of those manifold operations which are involved in the creation and supply of the ever-growing needs and necessities of mankind. Business is essentially creative; it aims at linking up the powers of Nature and of Man, at the minimum of waste in the methods and material employed. It creates plenty where once there was want; it makes a granary out of a wilderness; it bids a thirsty land riot with water; it stabs the frosty soil with spade and plough; it uncovers the bosom of Nature until she becomes pregnant with life and brings forth fruit an hundredfold.

This is not mere poetry; it is solid fact. Forty years ago the great prairie lands of the Canadian North-West were unploughed wildernesses—the haunt of the buffalo and his dark-skinned huntsman. Last year these same lands surrendered to the will of man nearly 350 million bushels of wheat.

Who did this great thing? Who but the business men that planned and laid the iron road—the miner, the

smelter, the engineer, the platelayer, the car builder, the pioneer with pick and spade who fought back Nature at the edge of her wildernesses, bridged her ravines, and split holes in her frowning crags. And so when Lord Strathcona drove the last spike home in the Canadian Pacific Railway, and linked 3,000 miles of East and West, he set the seal of these men to the contract in perpetuity between themselves and Nature.

For 5,000 years the Egyptian fellah irrigated his field with the shadoof—the oldest and simplest of all known machines—a long pole poised on a prop—a lump of clay for a weight—a cord—a goat-skin bucket—and the man himself. That was all. He poured water out of his buckets; he cast his bread on the waters by flinging his maize seed on the flood. What toil for a million backs! Then came Scott-Moncreiff in 1885 and Benjamin Baker in 1899 with their English engineers. The result was the Barrage near Cairo and the Dam at Assouan. The one vast lake became a network of canals—the wide valley a chessboard of fertility. Thirty years wrought the miracle which fifty centuries had failed to accomplish, and the land of the Pharaohs is to-day the richer by millions of pounds per annum. This romance is Business. It is Man the creator taming Nature to his will, with Science at his elbow. It is the human mind setting itself scientifically to eliminate waste effort and material.

Read the history of Alexander Graham Bell and the evolution of the telephone,[1] or of drab-coated Cyrus Hall McCormick who gave the world the cheap loaf and fed a continent with his harvester. Were not all these men creators? And so we arrive at our first axiom. *A business—*

[1] See Glossary.

that is, a scientifically organized system of creation—succeeds only when it is cheaper to buy its products than not to buy them. McCormick's reaper paid for itself in one harvest, and there are enough in Europe to-day—not to speak of its native home in America—to do the work of twelve million men.

But there is another and sorrier side to human history. There is the creator, but there is also the creature. Sometimes the environment is too strong for the Man; he cannot escape from it. The Polar Ice crushes him; the Torrid Suns shrivel him; he becomes Nature's slave. Whole races succumb to this compelling cause. Progress becomes for them a thing impossible. But there are other countries where the climate is more kind, nay, where its very vagaries act as a tonic to energy, yet where counteracting causes, moral rather than physical, operate in checking the creative powers of man. A glance at Modern England seems to show that some sections of our own people are suffering from this retarding influence. A bygone feudalism, subtly permeating through the Body Politic, and exhibiting itself in social cleavage, has left behind it as its legacy the astounding creed that labour is for the "lower classes" and that it is "bad form" to work. "White-handedness" up to the beginning of the war was still in certain circles regarded as the hall-mark of gentility. But these blemishes are not the only factors which have brought business into disdain, however much they may have infected with the malaria of snobbery certain sections of English society. If this were all, its votaries could for all practical purposes be disregarded, or, perhaps better, "scrapped," together with those educational nurseries where they have been bred and schooled.

There is, however, a broader cause. The country as a whole has retained a narrow and cramped view of business because its early interpreters had an insufficiently wide outlook; they failed, through lack of a proper education and through their insular prejudices, to grasp a high conception of its true powers and values. England has deserved something at least of the scorn implied in the Napoleonic sarcasm: "A Nation of Shopkeepers."

There has always existed a prejudice in Great Britain against new creations; for the less scientifically trained a nation is, the more inveterate are its prejudices. "What was good enough for our fathers is good enough for us," has been the rust-eaten motto over the door of some men's counting-houses. And the more prosperous the trader has grown, the more gross and fatty has become the degeneration of the trading heart. He has preferred the blunt thumb to scientific method. And yet that way lies national ruin—nay, to-day it has been brought home within our doors and stares us in the face.[1]

Here is another axiom, which should heighten the dignity of business in the eyes of those who have hitherto thought fit to disdain it. *The wealth accumulated by the man who makes business his life-work and thereby becomes a creator is a mere fraction of what that work has saved for the community at large.* The fact should never be forgotten that such a man creates a new need, or at least makes an old need more desirable, more easily obtainable, and therefore cheaper to secure. In either case he causes the life of the community to become less burdensome and more enjoyable. There is less human waste. There is more leisure. Contrast the life of the skilled artisan or of the labourer to-day and

[1] See the Glossary, *passim*.

his existence (for it was hardly worthy of the name of "life") fifty years ago. Though much remains to be done, he is better fed, better housed, and better cared for in sickness, than in the anything but golden days of old. His lot, though still too hard, is not so dark and hopeless. Which class in the community has contributed most to bring about this change? The Landowner, the Church, the Government? No! the chief benefactor of his kind has been the Business Man. Facility of transport, steam, electricity, labour-saving appliances of every kind—what has led to them all? The application of the creative power to Business—the linking up of the forces of Nature and Industry. Then throw into the scale the unrequited toil of brain—for nothing is more often forgotten by the unscientific mind than "negative instances"—the countless defeated efforts of the creative man of business before success is achieved—the brain-waste, and the struggle against disappointment and disaster, which not seldom await the creator of new ideas. This view may seem a romance to the Man-in-the-Street. Here are facts. There are 250,000 business firms in the United States. Over 100,000 of these have "no net income whatever." There are 90,000 of them which make less than £1,000 a year. There are only 60,000 of them—one out of four—that make more than £1,000 a year. These astonishing figures have just been made public by the "Federal Trade Commission" appointed by the American Government. Again it has been announced recently that there were over 22,000 bankruptcies in the United States last year. So then there are many dangers and difficulties in business life across the Atlantic from which we are comparatively free. Yet it has been on account of these very dangers

and difficulties that the United States have come so rapidly to the front in the development of efficiency. Business life speeds more quickly than in England. There are more rocks—more accidents—more shipwrecks. Hence there has to be more skill in the art of commercial navigation. If an historical analysis be made of all these things, and a creditor and debtor account be struck, it will be found that the profits of the creator, *i.e.*, of the business man, are only a very small part of what that industry of which he is the pioneer saves to those who buy its produce. Has he not then hitherto been, in spite of all his shortcomings, the chief benefactor of his kind?

The business man of to-day has begun to realize that it is not merely his function to create and provide what is needed by his fellow-man. His horizon has become more wide and clear. He visualizes that *in the process of creating and providing he must be efficient.* Modern conditions have become so complex that a business organization in the future must consist of a collection of Specialists controlled by an Organizer-in-chief. All business will inevitably tend more and more to concentration. The day of the small employer is far spent. The best of everything is not within the reach of the trader of limited means.

Organization then is urgently needed in business. The great Organizer will be the future Prince of Industry, with the salary of a Field Marshal; the small employer will gradually convert himself into a specialist under the orders of his Commander-in-Chief, with earnings far in excess of what he could win as an independent trader. *The rewards of industry will be for those only who render great services to the community at large.*

The business man of the future will himself create needs.

It may here be objected—This is a direct incentive to replace the simple life by one more complex. The reply is that the multiplication of needs is the inevitable outcome of the principles of evolution. Let us borrow a parable from Nature. In the amoeba, all the organs of life are in a coalescent state; their functional powers are extremely limited. In the higher orders of being, the organs become differentiated and the powers infinitely extended, until they reach their full development in Man. The foe of simplicity then is luxury, not multiplicity of needs, the organization of every one of which demands simplicity—that is to say—the speediest and most economical adjustment of means to end.

Business is a profession. It has in the past been depreciated in comparison with the traditionally recognized professions. It sets forth profit (so runs the argument) as the conscious object of its pursuit; in Law, Medicine, Education, the Clerical, Naval, Military and Civil Services, material gain is only the by-product, not the conscious aim; the work itself is done for the safety, honour and welfare of the country. Law, for example (say these theorists), is the maintenance of rights as between man and man, Medicine the preservation of his body, Education the betterment of his mind, Religion the security of his soul, while the Civil Services regulate his communal life, and the Navy and Army guard him from foes without and dangers within. And all those who pursue these careers have for their ideal a pure love and passion for the end in view; their salary, or wage, or honorarium, is the mere formal recognition, not the measure, of such services—the necessary means by which they can carry out their functions to the best advantage, *i.e.*, without being dis-

tracted by mundane care for themselves and their families. This is the grand and vital distinction (so it has been alleged) between Business and the Professions; this is the great gulf fixed between the one and the other. Gain is declared to be the conscious aim of the one; it is merely the by-product of the other. But, we answer, Business, properly conceived, is not only a profession, but a profession just as honourable, just as elevating, just as inspiring as that of Medicine or of Law, and distinctly more necessary. The Man of Business stands on at least as high a plane as the Man of Law and of Medicine, for while the latter employ their energies to redress what is wrong, he becomes the creator of new things and thereby contributes to make mankind happier and wider in life.

It may be objected again—Yes, but the conscious aim in the noble professions is not profit; in trade it cannot be otherwise. The answer is—This is a grand untruth. The lure of gain has an essential function in every sphere of human activity, for it stimulates in the mind of man an intensity of desire to achieve, without which no great result can be secured. But it is the self-determining character of the man, and not his calling, which decides his attitude of mind in this as in all other regards.

John Stuart Mill provides us with a lesson here. He teaches that in the moral world the conscious pursuit of happiness ceases to be happiness. It comes to us only as an aftermath, when we have consciously pursued some other and greater end. Like the bloom, it betrays, but is not, the ripeness within. So too it is in business. Profit need no more be the conscious aim than are the guineas laid on the physician's table, or the refresher on the lawyer's brief. There is a far-offness of view in the aim of the true

business man, as of all creators, which is not fixed on pounds, shillings and pence, but on something greater. He reaps his glory in the doing. His profits grow as the muscles of the athlete grow, because he exercises himself in doing. Nay more, by a psychological law, the less he broods over riches, the less he is absorbed in them; and the more he schemes and plans how to make himself indispensable to mankind, the more abundantly are his profits likely to accrue.

CHAPTER IX

THE HUMAN FACTOR IN BUSINESS

IF these things are so, what better or nobler thing than to be a business man?

At no time more than the present, when Great Britain has the opportunity of snatching the sceptre from the grasping hand of her chief rival and enemy, has there been need of the highest and acutest intelligence. Her future Captains of Industry must be men of courage and initiative, inspired with the grand passion for achievement—men with the dash of the soldier, and the enterprise of the pioneer.

The human factor in business is more than three-quarters of the whole, and if there comes into it a leavening of the brightest and most cultured spirits in the country, the ever-growing difficulties between capital and labour may find speedy and happy solution.

To what can these difficulties in the past be attributed? Surely to prejudices arising from ignorance, to a narrow and unsympathetic outlook, and not least to a lack of scientific knowledge on the part of the employer, to the blind and often cruel creed that a workman is a workman only, and never must be, and never was intended to be, anything more than a workman all the days of his life. On the other side of the Atlantic that old superstition died long ago, if indeed it was ever born. In that electric atmosphere, the spirits of endeavour and enthusiasm walk hand

in hand, and the outlook of employer and employed is, with rare exceptions, one of greater mutual confidence and understanding.

The Business Man in England has been apt in the past to regard his business as full of limitations. The limitations exist mainly in the mind of the man himself, not in the business with which he deals. The Wage-Earner has also been taught to look upon himself as a creature of limitations, who receives his pay for doing just so much and no more. So then, while the employer remains an unenterprising master, the workman becomes an unprofitable servant. If once a higher type of mind is fostered and developed both in Master and in Man, the whole idea of business will "suffer a sea-change" and be transfigured into a higher and a more reproductive instrument of power. Ardent spirits are needed for the accomplishment of this task. There is a romance in business which needs a soul on fire to send its message forth.

Let us shortly set forth some of the principles which will go to make up the ideal business of the future, and some of the fallacies which have restrained it hitherto.

1. The rewards for those who do great things, whether Masters or Men, must be ample and generous. There must be no keeping down of wages as soon as it is found that a workman can do more than was done by him in the past. This is not only the basest injustice: it is also ruinous folly. *The reward for increased speed and increased product should consist in the concession of fewer hours and higher pay.*

2. The idea that it is good policy to produce as little as possible lest the supply should outrun the demand is an

injurious economic fallacy. It is indeed an economic law which cannot be gainsaid that *the greatest possible production is always in the interests of the community at large.*

3. Whence come the cheapest goods to-day? They are produced by employers earning the largest profits and paying to their workmen the highest wages—profits and wages out-distancing the dreams of both a few short years ago. How has this great change been brought about? Through the discovery and application to business of the laws of efficiency, thus eliminating waste, which arises from the blind use of antiquated methods. Mathematically put, the equation stand thus:

Low profits + low wages = high profits + high wages—waste.

What is waste? It is the sprawling of the human factor aimlessly over its environment.

The first and hardest thing to be done is to kill the microbe of prejudice which eats away the vitals of trade. That microbe must be put into a brain-furnace; for it breeds myriads of offspring, but all have one surname—waste. Progress, the child of Science, is still in fetters, but at least it is struggling to be free. And that is always something.[1]

How can all this be best brought about? "Goodwill amongst men" is its first and most indispensable condition. And this is always easier to secure between strangers than between suspicious neighbours. Happily the horizon is clearer now than for many a long day, and the guns of Armageddon have done splendid destructive work in levelling the trenches which separated class from class, interest from interest, man from man. A healthier atmo-

[1] See Frontispiece.

sphere is being breathed to-day. And if that atmosphere can be made to permeate the world of business, Great Britain's industrial victory over her rivals is more than half won.

The parent wants to develop in his child those qualities which will make him the most efficient and reproductive citizen. What is the first thing he seeks for him at home and school? The right atmosphere, the best environment.

Apply this principle to business. Man is infinitely the most wonderful and complex instrument, as well as the most essential factor, which the commander-in-chief of a business has to handle. His first and chief aim then surely ought to be to create between himself and his workmen the right atmosphere. Man has *dynamic*—the dead machine only *static* force. A machine never grows more efficient from the day on which each bolt, nut, and bar, fall into their appointed place, though on the other hand it should not grow less efficient if repairs and maintenance are scientifically kept up. Still it is in a fixed condition always. But in Man there is *dynamic* force—he must either grow better or grow worse—he must either develop or he must shrink. It matters but little what a man is to-day —*the great matter is what he desires and intends to be in one, or two, or three years' time.* He is not a mere machine with two hands and two feet—but a living pulsating energy. He has a trinity of powers—spirit, mind, and hand, and the least of these three is hand. For it is only the spirit to do, and the mind to create that can make the hand move at all. And because the old school of economists failed to realize this fundamental truth, because in other words they neglected psychology, there has come to be, for half a century past, this hideous and unnecessary friction between the workers in the great brotherhood of labour.

These economists worked out their theories only in the icy terms of supply and demand—they forgot that man is more than a machine and that his spirit is greater than his hands. Hence came economic wars and rumours of wars. Hence the selfishness of employers and the bitterness of employees. Hence strikes. Hence the campaigns of Trade Unions, who battled for the rights of a dynamic manhood. Hence gradually growing troubles, which have dogged the steps of British trade in the past.

Our rallying cry must be—*Let us form the right atmosphere in the business world.* War has given us our best and only chance. However victorious in arms Great Britain may be, her future lies in her pre-eminence in the world's industries. Through it she will either rise as an Empire to a height undreamt of by former generations, or she will sink to the level of a second-rate nation. Now or never!

Let us remember that this high vision of Empire can never be attained unless we make use of the dynamic force of our Industrial Worker. He must bring his spirit and mind to bear upon his work—not his hands only. And this combination of human effort depends on the atmosphere breathed in common between himself and his employer; otherwise his hands are at variance with his head and heart. All effective action is determined by will-power combined with intelligence. And so it must be in the worker. An eager striving spirit, linked to a trained and active mind, will bring him into communion with his employer and his fellow workman. The first and highest problem then to be solved is how to evolve real men from the human raw material which presents itself at the office door and the factory gate. Then and not till then shall we learn how to produce and distribute in the best

and most efficient way the wealth that Nature has already surrendered to us and those still undiscovered bounties which she hides in store.

What a splendid opportunity opens itself out for the youth of this country to do this great thing—to change industry from the thing it has been into the thing it may be, and the thing it ought to be! If once enthusiasm and faith ripen, then the worker and his work, however humble or however lofty, become electrified, vitalized, and increasingly dominating in their power.

Viewed broadly, there is far more opportunity, as well as far more romance, in Business than in any other calling. For it is certainly too much to hope that the Civil Service career will so change as to raise itself into being any more than a life of dull respectability. Neither the brain nor the spirit is encouraged, and over the portals of many a Government Office the motto might well run: "All hope surrender, ye that enter here!" So fossilized are its methods, so swathed in red tape its traditions, that, as at present followed, it is not worthy of the activities of a man of force and originality.

With regard to other avocations—the Physician and the Clergyman are of high worth to their generation, specially those noble spirits in either profession, who "do good by stealth and blush to find it fame." Even the Lawyer and the professional Politician have their necessary uses in a still imperfect state of civilization. But who in the future will have in his power so largely as the Man of Business to bring light into dark places and to straighten the bent backs of a toiling Humanity?

Following out our method of bringing to bear the

evidence of men actually engaged in Business for the purpose of demonstrating the theories herein set forth, we conclude this chapter by an essay on the Ideals of Business from the pen of Mr. Angus Watson, of Newcastle —a man than whom no one is more approved by his countrymen.

The Ideals of Business

By Mr. Angus Watson.

The business man will not come to his own until it is universally realized that his service to the nation is as great as that of the preacher and the schoolmaster, and that the making of profits is only part of his many activities.

Business in the past has too often been merely a sordid effort to get rich quickly. Business in the future may be not only a means of a general wider prosperity, but an enormous educative force as well. The old mercenary point of view which regarded self-interest as the final goal of prosperity must be put behind us, and the new ideal which only regards a business complete to the extent that it develops the best activities of every employee connected with it, must be recognized and pursued. Badly paid and badly trained employees can never be anything else than unsatisfactory citizens, and since the average man spends the greater part of his life in his day's work, the employer must recognize that it is his responsibility that the man becomes something more than a mere chattel in the organization.

Let me try and tell you in a few words how I think the ideal business will be conducted in the future.

1. ... It will have at its head only men who "know how." The old method which gave a man the responsibility of the proprietorship of a business, or allowed him to become one of a Board of Directors, because he happened to be the son of his father, will have to go, taking with it the long week-end, the afternoon golf-round, and the constant absences from business—to be replaced by that of a man who thoroughly understands the business that he is engaged in; widely educated, not only generally, but technically; widely travelled, so that he may realize that there are still some things that Great Britain cannot do as well as her neighbours; carefully trained, having if possible been employed himself in the various processes of manufacture or distribution in which his firm is engaged. He will not manage his business as a director, but as a chairman. He will have constant conferences with the various heads of the business at frequent intervals. He will be in close touch with his workmen by the issuing of departmental letters which they will all be able to read, and, if he is wise, he will also have a monthly House Magazine connected with the business, which will set out the aims and ambitions of his firm, and will help his employees to understand how great a part individual efficiency can play in the ultimate success of the industry in which they are all engaged.

If the business is a comparatively small one, he can get to know the employees individually, but if a large staff is engaged, it will in the nature of things not be possible for him to do this. In this latter event he will appoint a small committee of workmen to represent the employee. These men will be in constant touch with him; will bring any staff complaints that his employees desire to

put forward, and will be able to feel that their suggestions are welcome, and not regarded as an intrusion.

2. Every employee will be a sharer in the prosperity of the business. There are a number of different profit-sharing schemes—many of them possessing advantages over the others as applied to certain businesses. One or other of these schemes should be adopted in connection with every successful business organization, and every employee who has shown his fitness to be on the permanent staff should be entitled to a share of the profits earned. I have no hesitation in saying that the time is not far distant when it will be impossible to conduct a great business without a project of this kind, and when the spirit of co-operation and conciliation will take the place of the present bitterness created by our Trade Union and Employers' Federation organizations.

3. Efficiency classes will be conducted in connection with every business. A few days every year can be very profitably given over to the teaching of the general principles of Business Efficiency, and for the study of the technical details in connection with the trade in which the organization is engaged.

An executive which does not know what is being done in connection with its own trade in other countries does not deserve to continue the management of the business.

Not only should they have this information for themselves, but any point in which the work is being done better by other countries should be passed on to the employees for their own consideration.

As an illustration of what can be done in this direction, I was taken recently through a large shell-case manufac-

turing plant which had recently been erected. For six months before the establishment of the business, the promoters of it had been studying the best kinds of machinery, and other labour-saving devices at that time employed in the industry which they were going to establish. Numerous plants were visited in this country and abroad, and then a model factory was established with the latest equipment. The employees were called together, and were told what the ambitions of the founders of the business were. A spirit of friendliness as between employer and employee was generated right at the commencement, and no one need be surprised that, as the result of this, this plant is turning out a larger number of cases—and these better made than any other plant of the same capacity in this country at the present time.

To sum up the whole matter in a word or two. Business in the future will call for the highest standard of efficiency, co-operation, and brotherliness, will make for the destruction of ignorant selfishness and merely personal profit, and will be recognized to have succeeded just to the extent that every employee connected with the organization is not only a better workman, but a better citizen.

CHAPTER X

SOME IDEALS OF SCIENCE AS APPLIED TO INDUSTRY

"Just as fast as productive processes become more scientific, which competition will inevitably make them do, and just as fast as joint-stock undertakings spread, as they certainly will, so fast must scientific knowledge grow necessary to everyone."—(H. SPENCER.)

THE unwillingness of the Englishman to grasp or act upon general principles is regarded by the foreigner as a marked national failing. Nevertheless there has always existed a minority of clear-thinking people in these islands who are neither blinded by prejudice nor blunted by indifference. Such men have for many years past been convinced that the chief obstacle to our industrial development has been the attitude towards Science adopted, whether from interested or disinterested motives, by school-masters, manufacturers, and politicians, and consequently by the great mass of the public, whose views must always be largely guided by these three classes of directing powers respectively.[1] Gradually accumulating evidence from 1874 to 1914 had proved to those unprejudiced observers that the reason why the United States and Germany were threatening, and in many branches of trade had usurped, our commercial supremacy, was clearly traceable to the fact that those nations had encouraged,

[1] The cause and cure of the neglect of Science have been set forth in chaps. iv, v, vi, vii; they need not, therefore, be laboured here.

while we had disdained, the employment of Science as the Nurse of Education and the Handmaid of Industry. But the warnings of these thinkers, until the war rudely disturbed existing values, were little more than voices crying in the wilderness. They had to submit to the same sneers and penalties that awaited Lord Roberts' warnings in another field. The old giants, the Gog and Magog of these islands—Prejudice and Indifference—hemmed them in on every side.

But the events of the past two years have opened the eyes of the nation, and brought conviction home to the minds of all sorts and conditions of men. It has become appallingly evident that Science has proved herself a dominating Mistress in the Arts of War no less than an indispensable Servant in the Arts of Peace. But this discovery, while it has forced upon us the necessity of studying her secrets, has not, in some quarters at least, increased her popularity. On the contrary, it has provoked a bitterness, which assumes the following form:

"Germany (it is declared) is the home of scientific training; if the result of her knowledge has culminated in what we have lately seen and heard, the less we have to do with the accursed thing the better."

This argument is as illogical as it is reactionary. It might as well be pleaded that because money can be spent in keeping its possessor in a perpetual state of intoxication it ought, therefore, to be kept wrapt up in a napkin. Such perverted moral thinking has received the highest religious condemnation and needs no further censure. Science itself teaches us that the disuse of a faculty earns a penalty no less severe than that which attends its abuse. It becomes atrophied. And the moral

stigma is equally in evidence. "The slothful man who hideth his hand in his bosom and will not so much as bring it to his mouth again" is no less undesirable a citizen than the swindler or the pirate, and infinitely more contemptible.

In a word, Science has no need to blush for herself, and to-day she has begun to make her voice heard in the streets, with a force which penetrates even the dullest of ears, with a persistence redoubled by the imminent peril of the nation, and with an eloquence which neither prejudice nor indifference is able any longer to gainsay or resist.

Naturally that voice has found clearest and earliest expression in scientific circles themselves.

Early in February a memorandum was published, signed by thirty-six of the most distinguished representatives of Science, urging its claim as the main feature of future education in this country among all classes. After pointing out that only four men equipped with scientific knowledge were presiding over the forty colleges of Oxford and Cambridge, and that not a single scientist directed the training received at thirty-five of the chief Public Schools in the country, they pressed for an organic change, which should include compulsory science among the subjects set for entrance into the Public Services, whether Military or Civil.

The views expressed in this memorandum were immediately endorsed in a document, hardly less influential, signed by twenty-two Professors of the Imperial College of Science and Technology, endorsing the views of the representative men, and quoting the dictum of Professor Huxley, uttered nearly thirty years ago, to the effect that—

"There is hardly a branch of trade or of commerce which

does not depend more or less directly upon some department or other of physical science—which does not involve for its successful pursuit reasoning from scientific data.

Not content, however, with a general endorsement of the claims of Science as applied to Industry, the same Professors at the beginning of June followed up their attack by practical proposals with a view to Government action. These proposals were embodied in a memorial insisting on—

1. The removal of obstacles.
2. Guidance to parents and public.
3. Grants of public money.

A general demand was also made that the Government should speak plainly to the country on "the subject of national education."

The problem of endowment which formed the third article in this important memorial is practical enough, and admits of speedy solution. A plea was made for a grant of £500,000 a year towards the establishment of bursaries at State-aided Secondary Schools and of research fellowships at the Universities. This proposal errs on the side of excessive modesty, the sum asked for being only one-tenth of the expenditure incurred daily in the prosecution of the war.

Meanwhile, a meeting convened by Sir E. Ray Lankester in May on the neglect of science and attended by a number of educationists, not exclusively scientific experts,[1] had passed unanimously resolutions in accordance with the views expressed in the memorandum of the representative men in February.

[1] The meeting included among its speakers men of such varied attainments as the Poet Laureate, Dr. Macan, and Mr. H. G. Wells.

These resolutions were forwarded by the meeting for the attention of the Government.

Voices from manufacturers and captains of industry all over the country were at the same time heard advocating a similar policy, though there were not a few who viewed with grave suspicion any State interference with or surveillance over, Trade and Science.

The Government itself, however, has not been exactly idle. In the summer of 1915, they had gone to the length of appointing "an Advisory Council for Scientific and Industrial Research."

And now, there comes the promise that "a Special Committee to inquire into the question of scientific teaching" will be appointed at an early date, and form part of the Reconstruction Committee. Lord Crewe, however, speaking on behalf of the Government, makes the somewhat cryptic statement that "it is clear that a review of our education cannot be regarded as strictly one of the subjects of reconstruction after the war, but, on the other hand, the two things cannot be disconnected." This does not sound encouraging for the advocates of sweeping reform.[1]

After this brief recital of recent history we proceed to the general question. What is this Science which we seek to expound? The representative men in their manifesto of February defined it thus:

> "The ascertained facts and principles of mechanics, chemistry, physics, biology, geography and geology;"

[1] See *The Times* of July 1st, 1916.

while its aim cannot be more nobly expressed than in the late Professor Tyndall's lofty language:

> "The knowledge of the laws by which God's universe is sustained and the perpetual advancement of mankind is secured."

The true function of Science then is the discovery and verification of those laws—not merely of dead matter, but of life in all its manifestations. The end is the same as the end of all knowledge—which is, in the words of Bacon, "God's glory and the relief of Man's estate." This is a high ideal, and he who uses it for such a purpose may justly be regarded as a benefactor of his race. Can such an ideal be achieved through the linking up of Science and Industry? It is the belief of the writers that it can, and that chiefly by this means can the claims of Science be justified.

Unfortunately the scientist has often failed to use reproductively the matter on which he works. His methods have not seldom been open to the charge which he himself has brought against the dry-as-dust classicist, who spends laborious days in dissecting the comparative values of Greek particles, instead of devoting himself to imbibing and reproducing the great thoughts embodied in the language of which he is the student. In a similar way the laboratory-research-worker is in constant danger of becoming a scientific sciolist rather than a true scientist.

Another charge, however, made against Science and scientific men, is not only unfair, but indeed grotesque. It, however, seems to need rebutting, because it may gain audience in minds which more valid argument fails to impress.

"Science is a house of so many mansions that many

of its inhabitants are not even on bowing terms. It ranges from cataloguing microlepidoptera to electrical engineering, etc."

In other words, the charge is that many men of science are entirely ignorant of any subject except that which they have made their special study. This argument, if seriously conceived, and not meant as a cheap sneer, is in effect a complaint against the organization of the Universe. According to these critics, the operations of a Creative Power ought not to be so vast and complex as to pass a single man's understanding. Such a view suggests a type of mind which is continually looking through the big end of the telescope, which would prefer as the object of its worship a Tribal Deity rather than a Universal Intelligence, and would abandon a citizenship in the vast sweep of the British Empire for the primitive simplicities of a residence in the Garden of Eden.

Our contention is that, though Pure Science, as a motive power "for the relief of man's estate," has its limitations, Applied Science recognizes none.

One chief aim of British Industry in the future must be the employment of the most able scientific advisers. At present such advisers are often mere students of third-rate ability and knowledge. The result is that they hold no recognized position, while their deficiencies are easily detected by foremen and workmen of superior intelligence, who have been conducting operations by the blunt thumb of empirical knowledge. The application of scientific methods is thus often laughed down and despised.

How is this to be changed? First of all, by Scientific Research encouraged by the State—research on behalf of

the industrial and agricultural interests of the country. *Progress depends on the rate at which a nation converts the principles and theories of science into terms of ascertained fact.* It is not the place here to allude to what the State should do in subsidizing scientific education. But, in addition to such aid, the endowment of further research must be made on a substantial, nay a generous and even vast scale, for the next quarter of a century.

What has been as a matter of fact achieved by the Government up to date in this direction, under pressure of the revelations brought to light by the War? By what means has it proposed to repair the serious gaps in our industries, their partial and in some cases total disappearance from Great Britain, and their exploitation by aliens and enemies? How does it set out to safeguard the nation against such a catastrophe in the future? There has been an almost universal confession that the defect is attributable to the neglect of science among politicians, manufacturers, schoolmasters, and indeed among all orders and ranks of our people. What form of perpetual absolution has the Government ordained and pronounced in response to this urgent call for better things? There is no apparent sign yet that the Government realizes the enormous importance of the matter involved. The spirit of the nation is changed, but the official spirit remains the same —the old pettifogging spirit which exhibits itself whenever any scheme reaching far into the future comes under its survey—the spirit which lives from day to day not knowing the hour of political death.

After all allowance is made for the fact that our national resources are strained to the breaking point to meet the exigencies of war-expenditure, yet the govern-

mental response to the universal voice is pitiful, niggardly, practically valueless—a mere drop in the ocean in proportion to the urgent need.

> "It (the Memorandum of the Board of Education) appears to contain no provision for instituting the best, and perhaps the only real, method for encouraging discovery as distinct from investigation—and the two things are quite different.
>
> "*Prima facie*, the Board of Education's scheme is one for the cultivation rather of petty science than of Science. It proposes to devote a Parliamentary Grant of (we understand) £25,000 for the purpose, this being administered by a Committee of the Privy Council, consisting principally of the inevitable party politicians, advised by another Committee of Men of Science. The money is to be expended under the head of instituting specific research, developing existing institutions, and awarding research studentships. . . . Great Science is not made in this way. It requires immense labour, complete devotion, and, above all, an intellectual capacity which is not possessed by the vast majority of men—even of scientists."[1]

£25,000 a year! That little pailful, and no more, to be ladled out by a party of politicians who may be unable to distinguish between lard and lavender! Will our rulers never learn that Public Opinion is now in such a mood that it wants no "sops to Cerberus," but that it has a contrite heart for past shortcomings in the sphere of scientific knowledge, and is ready to submit to any expen-

[1] *Science Progress* of October, 1915, pp. 522, 523.

diture which will secure the continuous supremacy of Great Britain? Let us confront these miserable figures, which savour of the "old economic gang" of the middle of the last century, whose motto was "cheapness," with those proposed in these pages, premising that the generous and even lavish expenditure of public moneys for a clearly defined end in the near future is the truest economy, provided that it be scientific expenditure, entailing no waste.

CHAPTER XI

SCIENCE AND THE STATE

TO-DAY we stand on the threshold of Nature's mystery-house. We are only beginning to peer through its half-open door. The last 150 years have witnessed a multiplicity of inventions and an adaptation of new industrial and scientific processes following so hard on the heels of one another as to exceed the sum total of all that man has conceived since he became a sentient being. Scientists tell us that from Pleistocene ages onwards—a period of at least half a million years—there has been little or no change in the form and size of man's brain. Certainly during the period covered by human history—perhaps 8,000 years—there has been no apparent change in the gross anatomical structure of that organ.[1] Yet for 7,850 of these years, taken all together, man's brain discovered and applied fewer of Nature's secrets than during the last 150 years. Discoveries and inventions are now increasing in a geometrical ratio. *We venture to say that nothing in any department of industrial life is being done in* 1916 *as effectively as it will be done in* 1926. The nation which is the speediest to assimilate this truth will outstrip all others, not only in industrial, but in every other department of human activity.

In other words—*the progress of our nation will depend on the rate at which we turn the principles and theories of*

[1] *The Educative Process*, by W. C. Bagley, p. 17.

science into its ascertained facts. That the State should provide on a lavish scale the necessary institutions and instruction calculated to give the nation the right men for this colossal task is the merest prudence. Our national wealth enables us to hasten our rate of progress more effectively than any other European nation. Research, thus provided and carried out as it should be, would increase that wealth beyond all calculation. It would, among other advantages, pay for the war more quickly than anything else. Industry needs what Research would bestow on it, just as much as it needs intelligent workmen, with whom the nation would be able to provide itself through a proper system of elementary and technical education.

Can such a temper of mind as could be persuaded of these things and achieve them be found among the manufacturers, the scientists, the politicians, and not least, the schoolmasters of the land? Or, are our captains of industry of such a habit of mind as still to repeat the same old formula:—

"Take it or leave it,"

while their rivals "scrap" their machines and methods, as soon as science indicates to them something better? One way national bankruptcy and ruin lie; the other leads to success and victory.

This brings us to our figures. If we spent £5,000,000 per annum (not £25,000!) on the promotion of scientific research and the application of science to our industries and to our agriculture, it would be merely 1-500th part of the national income of £2,400,000,000.[1] This com-

[1] Germany is said to spend £1,500,000 annually in this cause.

paratively insignificant expenditure would ultimately be repaid to us a thousandfold.

Any thoughtful man of business knows that, *directly scientific knowledge is applied to the problems of production and organization, so surely are all previous estimates of possible earnings outdistanced to such a degree as would seem fabulous to the uninstructed mind.* Apply this principle on a grand, a national scale, with all the natural resources of a world-wide Empire at our disposal, and there are no limits which can reasonably be set to our future prosperity.

Racial genius, in spite of all drawbacks, reasserts itself when surrounded by more wholesome environment. It is an ultimate factor in moulding national life, and, however artificially stinted of its full expansion, cannot be altogether killed. And the racial genius of the Briton is inventiveness. Naturally, he is the greatest of all discoverers. In the United States, the majority of inventors and leaders in every sphere of human activity are found to be of English blood. The German on the other hand, whether "hyphenated" or in his European home, is a patient and thorough copyist, but has feeble inventive power. He adopts, he adapts, he purveys, but, generally speaking, he does not invent.

So then, if the energies of the scientist and business man, equipped of course with an ideal education, are given free play and encouragement by the State, Great Britain will, we believe, rise in one generation to a pitch of prosperity such as the world has never seen before.

In order that we may show how these ideals could bear fruit in the field of practical politics, let us indicate

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some at least out of the many ways by which they could be attained.

1. Central laboratories might be established by the State all over the country manned by the ablest scientific men possible to find.[1] These men would have under their control a large body of scientifically equipped assistants, selected at the end of their scientifically-directed educational career. Both principals and assistants would have to be paid so generously that the best intellects could look upon such appointments as prizes in life, and as opening out the most reproductive of all careers both from a material and an intellectual standpoint—*a career honourable to all men.* The laboratories would vary as regards apparatus according to the special character of the products manufactured in the different centres in which they would be situated. The smaller firms in the country would be encouraged to send their raw materials and finished products to these laboratories to be tested. At the present time, the majority of smaller firms use no expert and consult no laboratory, the reason being that they cannot afford the cost.

2. Another scheme, which would find more favour with those who fear the consequences of putting research or any other undertaking which requires freedom into the hands of the State, has been sketched in chapter vii, page 66.

3. All conditions point to the conclusion that small industrial concerns must ultimately give way before larger ones, where alone goods can be made in the most efficient

[1] Australia has already addressed herself to this problem. The Premier, Mr. Hughes, insists on the establishment of a National Laboratory, and an extension of education in science to every child in the Commonwealth.

way. With regard to the larger firms, each should have a private laboratory, and a thoroughly equipped scientist spending his time in improving, adding to, or simplifying, the processes of the manufacture.[1]

One reason why this system is not as extensively carried out in this country as elsewhere is, no doubt, a complete lack of appreciation of its possibilities. Moreover, students from technical schools and graduates from scientific colleges are in many cases "pure" and not "applied" scientists—academic minds such as have been portrayed in the last chapter. A man of purely scientific attainments is useless for such a purpose. A knowledge of test-tubing does not qualify a man for the superintendence of vats.[2]

4. The metric system of weights and measures, and the decimal system in coinage, should be introduced throughout the commercial and industrial world of Great Britain. Such archaisms as £ s. d. and the three-column system, the rod, pole, or perch, and the difference between the nautical and geographical mile, should be consigned to limbo. It has been calculated that the brain-fatigue and labour-saving in education as well as in industry by the adoption of the decimal and metric system would result in an annual saving to the country of millions of pounds.[3]

Where Science has already found practical application, t has wrought great wonders.

[1] The following is the *proportionate* number of chemists in various European countries, after the respective populations are reduced to the same scale: Switzerland, 300; Germany, 250; France, 7; England, 6. No wonder that in all the industries where the chemist is predominant, Great Britain has been left far behind by Germany.

[2] See *Science and the Manufacturer*, by Keith Quinton, p. 27.

[3] See *The Financier* of March, 1916, and the Glossary.

Look at the cobbler half a century ago bending over his bench, and turning out three or four pairs of boots a week and then picture the thousands of pairs of infinitely greater comfort and better appearance rolling out daily from the modern factory. What is the explanation of the achievement of this gigantic change? *It is to be found in the human mind applying itself scientifically to eliminate waste effort and material.* There is no product now being fashioned by the hand of man which his mind, if set scientifically towards that end, cannot multiply incalculably—no acre still lying barren and untilled in the field of human activity, which the mind of man cannot plough, and cause to bring forth a hundredfold.

In the development of latent human power through the scientific training of mind and hand will be discovered the Open Sesame to priceless treasures for future generations of mankind.

This is no dream, but a waking vision.

It is safe to say that, by means such as have been sketched, the saving of waste and the inventions of new methods and materials would defray the whole expenses of the great war in one generation. Assuming that 3,300 millions of pounds will have been spent by the Empire, we shall require a disbursement of 100 millions a year to wipe out the principal in thirty-three years, a little over 4 per cent. of our present income, which is now estimated at 2,400 millions. But that income is as nothing compared with what it would be, if Industry and Science joined hands.

We have come to a clear parting of the ways—one road leading to general national decadence, the other to national and imperial prosperity. The mind of the nation

is ready to welcome big measures, big expenditures, big changes, and, above all, big guidance, to an extent and with an openness of view and freedom from party prejudice without parallel in the history of our people. Now or never! We look for Great Leaders who will greatly lead. Will the Great Occasion bring them forth?

By way of practical illustration of some of the problems raised in the foregoing chapter, we append a monograph on the Coal Tar Colour Industry by Professor Perkin, F.R.S.

Coal Tar Colour Industry

By Professor W. H. Perkin, F.R.S.

The story of the Coal Tar Colour Industry, involving its brilliant rise in this country and subsequent emigration to the Continent, is so well known and has been so frequently elaborated as an object lesson in regard to our system of chemical education, that repetition becomes unnecessary. Detail, again, as to the value of our discoveries in this respect during the last thirty years is needless, because these are almost too trifling to merit comparison with those which have emanated elsewhere. The warnings which have been given from time to time have fallen upon deaf ears, and though, owing to the war, these have been again voiced with special insistence, it seems certain that many of our scientific teachers and leaders do not appreciate even now the value that such an industry would bestow on this country, or, if they do realize it, the colossal character of the effort necessary to regain it. This condition of things is in part to be attributed to our Patent Laws, and the difficulties surrounding the use of alcohol

for industrial purposes; but, on the other hand, the attitude of our teachers, educational authorities, and our manufacturers themselves, has been of much greater importance. The latter, it would appear, from a lack of courage, or may be from a short sighted policy, have refused to employ, at least in sufficient numbers, adequately remunerated chemists of high-class attainment who have been specially trained in this subject. The manufacturer again has pleaded that such chemists could not be obtained in this country, and has consequently blamed our Universities and Technical Institutions as being of little value to his industry. Supply, however, follows demand, and there can be little doubt that, had the manufacturer insistently pressed for such men, been prepared to pay them suitably, and offered them a permanent career, he would in the end have obtained them, and at the same time have materially raised the standard of the teaching of his subject. On the other hand, it has been surely the duty of our Universities and Technical Colleges to create not only the chemist, but the manufacturer of colours himself, and in this respect they appear to have lamentably failed. In fact, among the majority of our scientific heads, there has been no enthusiasm for the subject, and the special feature which has been inimical to the advance of the British Colour Industry has been the bias of many of our eminent teachers against the research in pure synthetical chemistry, and in favour of chemical work, organic or otherwise, which involves physical considerations. This, though veiled in expression or perhaps coupled with such terms as "compound making," "chemical jugglery," and the like, has without doubt in cases affected the mind of the young enthusiastic

student, and diverted his original attention into other channels. Thus, whereas our Universities have been and are creating scientific men who rise to high eminence and are second to none in their particular branch of chemistry (and it is certain that our chemists are in no way behind those of Germany in originality and mental qualification), English colour chemists have been more or less conspicuous by their absence. It is again unfortunate that, owing to the insecurity of tenure possessed by the works-chemist, and the conditions of factory life in the past, many of our best chemists enter the teaching profession, and thus become more or less lost to the industries. Again as the result of technical movement, which was to be the *vade-mecum* for all our industrial ills, colour chemistry, at least until recently, experienced no material benefit. The erection at vast expense of so-called technical schools in almost every district has no doubt served a useful purpose in bettering the outlook of the average worker, has supplied the works with young men capable of carrying out intelligently routine operations, and taught them trades and handicrafts, but has been of little or no value in creating the leaders of industry so urgently required in this country. There exist, however, certain higher class institutions, notably those which are either part and parcel of a University, or are affiliated thereto, which are now working in the direction indicated, and of importance is the fact that degrees are now awarded as the result of examination of which the principal subject is of a so-called technical character. Until recently this was not the case, and there was thus presented to the mind of the student a harmful distinction as to the relative merits of either a pure scientific or a more specialized training. It, indeed,

has been the view, and may still be, among some chemists of eminence that so-called "chemical technical education" possesses little merit, and that, after a high scientific training of University character, the factory itself should quickly add the necessary technical experience. Considering the immature nature of much of the so-called technical instruction, even of the higher class, at that time, this contention was in the main sound, but experience has now shown that technology, scientifically treated, involves little or no loss of scientific knowledge, and provides a valuable asset to a student about to enter upon an industrial career. In the writer's opinion, the only satisfactory technical course, at least in colour chemistry, must be one of University character, where the student is first trained in pure science, and then passes into the Technical Department where his special subject is dealt with from a high scientific standpoint up to degree standard. Such a method possesses the advantage that, if judiciously carried out, it brings the student early in contact with simple problems which bear upon his future career, without impairing the thoroughness of his general training, and creates the enthusiasm for his subject which is so necessary for the future attainment of success. Most important too, especially in regard to colour chemistry, is some connection, if possible, between the Technical Department and a factory or factories of standing, a feature which has been of so much value to laboratories on the Continent, and which might be extended with the greatest advantage to all the Universities and affiliated Technical Colleges in this country. Such an arrangement, if not allowed to deteriorate into a mere money-making consulting practice for the benefit of the Head of the De-

partment, and carefully arranged with adequate safeguards to protect the interests of the factory, should not only be beneficial to both parties, but indirectly of service to the country itself. Further, the mutual distrust, unfortunately so common, between manufacturer and professor, would, as has been the case on the Continent, gradually disappear. In so short a statement it is impossible to deal with many of the phases of this difficult subject, and a discussion of the vital relationship of pure organic research to the colour industry has been avoided for want of space. It is certain, however, that, if we desire to regain our share of this very important industry, we have a colossal task to perform, and several years must elapse before we can anticipate arriving even at the present perfection of the German Colour Industry. As an effect of the war, there is some hope that many of our legislators, scientists, higher educational authorities, schoolmasters, and manufacturers, are becoming alive to this problem, and that the colour industry, regarded by many as being irretrievably lost, may perhaps, after all, be, at least gradually, reinstated in this country.

CHAPTER XII

GREAT BRITAIN UNLIMITED

"Where there is no vision the people perish."

WAR, the Arch-Devastator, becomes in its operation a creator. While it destroys man's body, it creates in him a new spirit.

But here candour bids us pause. That spirit has not yet been born in some sections of our population, or at least is only just beginning to awake to conscious life. The grim lessons of War have not been driven home in all quarters of our land, though the insular Briton is somewhat apt to suppose that his nation stands out as the *beau-ideal* of noble qualities. Let him look at France. While her universal heart was from the first aflame with white heat, ours is, in parts at least, still cold. Indeed, the collective ethical expression of our allies has been on the whole, we must fain confess it, higher and deeper than our own. Patriotism in Great Britain has even yet in some quarters been shrivelled by self-interest.

Notwithstanding, we are convinced that a new and purified spirit is slowly but surely permeating the nation. It is this new spirit which we must make permanently our own, if we and our children are to enter the Promised Land of Empire.

Let John Bull look upon this picture and on this. Let him first scan the startling and alarming facts set forth in our Glossary—the shifting of the centre of trading

interests from our own to alien lands—the partial or wholesale disappearance of home industries and inventions, and all the loss in national assets which that disappearance involves.

And then let him turn his eyes to the other picture—the inexhaustible resources of our Empire—some of which are not only still undiscovered and unexploited, but not even yet guessed at in extent and value, though laid bare to the prophetic eye of the geologist, the mineralogist, and the scientific chemist. Let him look at Canada, with only one-tenth of her rich bosom as yet scarred by the plough, her womb not yet pregnant with those harvests which could feed the whole population of the earth; with her undeveloped coal mines so vast that it is calculated that they could warm and light for a thousand years one thousand millions of the human race; with her yet unfathomed oil reservoirs in the folds of the foothills; with her untold wealth of minerals waiting to be unearthed from the cliffs of the Rocky Mountains, and with her inexhaustible forests of timber still standing in the giant trunks of British Columbia.

Let him fix his eyes on the vast continent of Australia, still inhabited only by a fringe of men, with her millions of unclaimed acres of pasture and arable land, and her mines pouring gold from East and West into native mints —Australia, which, with her Sister-Dominion, New Zealand, could breed enough sheep and cattle to feed the Empire.

Then let him move on to India, with its stores of tea, rice, jute, cotton, and countless wealth in precious stones. On to Ceylon, with its rubber and cinnamon and pearls. Then on again to Egypt and the Soudan, with all their

still undeveloped wealth in cotton, gum, and cereals. Or, flinging his gaze downward to the Far South, let him survey the terraced ridges of South Africa, streaked and seamed with veins of certain gold, and the blue-clay scoops where lurk still the unearthed gems of the Diamond Fields. Then onward to the Falklands—the fertile home of sperm oil in the midst of barren seas—to the sugar fields of the West Indies—the mahogany of British Honduras—and the pulp and fisheries of Newfoundland.

Over this vast sweep let his eye rove, and let him conjure up in imagination what all this means for him and for all who are British born. Let him remember what sweat and blood it has all cost to those who have gone before, what dignity, honour, and wealth it will mean to those who will come after him. And then let him ask himself: Shall I let all these things go? Shall I not prove myself worthy of this inheritance—I, who am the Trustee of the greatest Empire on which the sun ever shone?

Office, says the English Philosopher, ever shows the man. It either makes or mars him. The crown of this glorious inheritance bequeathed to us and our generation is not a thing to be lightly worn, for it has not been lightly won. As is the privilege, so is the responsibility. "Little they know of England who only England know." It falls then to our care to see how best we can change Great Britain Limited—limited by narrow insular vision, age-rusted economic prejudice, cumbrous complexities in law and politics, ecclesiastical jobberies, and social snobberies—into Great Britain Unlimited.

Has the Insular Briton—who would resent being called a little Englander—ever dreamed this dream? Has it

ever become for him an open vision? Never was there such a time for a clean sweep, and not least in the industrial sphere, on which, as we have shown more than once in this book, the whole future destinies of the Empire hang!

Miracles have happened since the war began. Millions of workers have been withdrawn from the field of industry to the field of war. And yet British hands—a mere weak fraction of Great Britain's whole self—are producing more goods to-day in some departments of industry than ever before in her history. What has been the cause of the miracle? It is simple enough. It is but the pouring forth through the burst floodgates of long dammed up British energy. And yet, alas! that is hardly an accurate imagery of the facts; since for more than a generation that accumulated force has been wasted, and vaporized into thin air. The image should take rather this shape—the putting forth of the force of an unpractised arm, made flaccid by disuse, and forbidden to exercise itself to its full power. *The productive energy of this critical time is the result of a temporary suspension of the laws ordaining restriction of output.*

So then the worker no less than the thinker and the patriot has to ask himself these searching questions. If this can be done in the green tree, shall we not will that it should continue to be done in the dry? If this be the striking power of the unpractised arm, what immense reserve of energy must be latent in the whole body, scientifically trained? And further, if the putting forth of this industrial capacity be, as it is, the only possible way to preserve the continuity of Great Britain as a World-Power, must it not be the supreme duty of every patriot to sweep away all those hindrances which have beset us

in the past—the jealousies and suspicions between class and class, engendered and encouraged by tainted and interested agencies on both sides, by narrow, unscientific, and overbearing capitalism on the one part, and by easily captivated and easily misled labour on the other? Instead of every man feeling that his hand is, or may be, against his neighbour, this war has taught us, both in things industrial as well as in things military, that hand joined with hand, and shoulder pressed close to shoulder—is the attitude that leads to victory, and brings security to the Empire.

And now to descend from the general and spiritual aspect of the matter to the particular and practical. Consider, for instance, the future of our great Cotton industry. A serious problem is set for us to solve in the fact that the United States, on whom Great Britain has depended for raw material, is year after year consuming within her own borders a larger and larger proportion of her crop. In this year (1916) she will require for her own purposes six to seven million bales, that is, nearly one-half of her whole produce. Contrast this huge consumption with that of ten years ago, and the consequences seem clear enough. We shall have to look elsewhere in the immediate future for our raw material. Where is such relief to be found? The answer is obvious. Within the bounds of our own vast Empire. There are millions of acres in Egypt, n the Soudan, and, of course, in India, where all the cotton we are ever likely to require can be grown, provided we call science to our aid, which will teach us, through research and experiment, how, when, and where to provide the culture of the right sort to suit all the various soils.

Look at Timber—and here again let us borrow a lesson from our chief enemies. Germany, in spite of her teeming population and her self-supporting areas of agriculture on poor soils, yet has found time to develop her forests through scientific study in the best school of Forestry in the world. With science as her helpmeet, she earns an annual income of £8,000,000 from her sale of timber; and so skilful is her manipulation of the industry, that, like the widow's cruse, the more it is drained of trees, the more room is found for the saplings to grow. There is a never-ending re-production.

Now turn back to the British Empire and her boundless stores. Not to speak of the lumber-trade in Eastern Canada, the Empire owns in British Columbia vast forests of the finest trees in the world, though hitherto cruelly devastated by fires accidentally or maliciously caused. A system of afforestation scientifically developed would not only supply our Empire, but become a source of imperial income to which the German revenue could never hope even to approximate.

Or take Coal. The coal of the Motherland, unrivalled in quality, if economically won, and scientifically used, would give us the cheapest power upon earth. It needs but the application of unrestricted labour, and, above all, of scientific process, to achieve this consummation—a consummation which would not only make us fabulously rich, but also make us wondrously clean, so that we should be barely recognizable to each other. What sceptic will dare to maintain that the days of miracles are past? Let him listen to one which Science, the great Conjurer, has power to work if we will but use her. Seventy tons of soot fall every month on each square mile within the

precincts of the great city of Manchester—not to speak of the mighty "sweeps" of other industrial areas. By the wave of the wand of science, allied to the organizing power of the business man, those countless tons of foul and unconsumed material—now lying like an abomination of desolation where it ought not—these sprawling acreages of soot may be converted into countless useful products and raw materials of industry. Will it be believed (and yet it is a sober fact) that the present wastage in by-products of coal is greater in annual value than the entire world's output of gold? That value is to-day going up our smoke-stacks, puffing itself out into our faces, defiling our country-side, poisoning man and beast and plant—in one black burial blent. The day is at hand when no coal as mined will be burned openly. The power needed for manufacture and light will be generated at the pit's mouth, and will thread its way through millions of copper arteries to the heart of manufacturing cities. At the pit's mouth it will be purged of its by-products. At the pit's mouth tars, and oils, and spirit, together with the by-products of pitch and gas and sulphates, will be separated by the winnowing fan of the scientist. Plants will receive the sun's kisses on lips no longer begrimed with sooty rains; and men and women will waste a smaller percentage of their weekly earnings on the soap-maker and the washer-woman. Railway directors will, indeed, be the only traders to bewail so clean a revolution, for they will have to store their empty coal-trucks in their sheds for a little while, until they can scour them out to carry other and fairer produce which nature will then be more bountiful in bringing forth.

And the rest of us who are not railway directors will

find comfort in the thought that we are saving millions of pounds per annum, once squandered in the freight of coal, which, transformed by Science at the pit's mouth, will trip through arteries from the mine to the mansion and the factory.

Petrol at 2s. 6d. per gallon will be no more; for the Empire will own its own spirit supply, and the motor, the aeroplane, the submarine, will find self-propelling means within the confines of Great Britain Unlimited.

These vast changes—apart from their economic and aesthetic urgency—will be forced upon us by the calls of national interest and national security. War has forced industry and science into the foreground, and cries to us in unmistakable tones: "Either do these things, or die." War has taught us the unparalleled stimulus which the free exercise of human energies can give to all those productive processes which are moulded by the hand of Man.

And here comes in yet another miracle. *Every new development in industry creates a score of accessory developments, so that if once we as a people take in hand the organization and development of our Empire on business principles, we shall enter upon an era of expansion the like of which the world has never known.*

But the whole united force of the Empire must be flung into the task. Men and women must put their backs, and not their little fingers, into the development of Great Britain Unlimited. The mincing affectations of white-handedness, whether bred in Homes, or Schools, or Universities, or Society, must be seen no more. Over the doorway of each workshop must be written the legend:

"If thou wilt not work, neither shalt thou eat."

Woe to him who shall hereafter say to any worker whether by head or hand:

"Thus far shalt thou work and no further."

Again, all *laissez-faire* must go by the board. In the old Latin lesson-books we were taught to repeat parrot-like the old legal text: "What a man does through somebody else he does by himself." The Middleman has thriven on that legend. For half a century we were spoon-fed economically on such a doctrine; we were taught to believe that for the purpose of "seeming cheapness" it was better to allow other nations to do for us things which otherwise we could do ourselves. What has been the result? To take one example out of hundreds—Germany and Austria have piled up enormous wealth in providing us with sugar, which we could easily have supplied for ourselves within the bounds of our own Empire. The result has been incidentally the ruin and the practical snuffing out of one of our greatest Imperial industries.

CHAPTER XIII

A VISION OF EMPIRE

WE have already shown in these pages how the old economic creed with which we were inoculated in the nineteenth century, with its bloodless doctrines of the eternal ratio between supply and demand, left out of its articles of faith the psychological factor and treated men as machines.

There was another fundamental error. It ignored the "invisible increment" of scientific and industrial creation. Whenever we develop a commodity directly or indirectly from Nature's storehouse, we evolve "brains" in the process. We bring to birth problems, the struggle towards the solution of which results in directing the mind of ourselves and other men into a thousand and one channels undelved before. More fortunate than the heroine of the Arabian Nights, we not only stave off industrial death by the creations of our own fancy, but we produce by a mental evolutionary process an ampler industrial life. We become, in fact, possessors not only of the commodity at which we consciously aim but of many others in its train. *This "invisible increment" is, as every originating mind knows, a vital factor in all industrial and scientific operations, and is, moreover, a constant phenomenon in all the stages of educational evolution.* The writers, each in his own line of life, maintain this truth with all the energy born of their practical experience. But, as regards at least the industrial sphere, though that experience might be

illustrated by what has happened during the last two years, "a big ox sits on the tongue."[1] There are still Germans in our midst; and, to parody a Porsonian epigram,

> The Germans are spies,
> All ears and all eyes,
> Except only Hermann,
> And Hermann's a German.

And why, because the units of our Empire are sundered by thousands of miles of ocean, why should that Empire sprawl across the earth in a state of half-suspended animation, inept to move, and exerting itself only to absorb what comes within the compass of its suckers, powerful to take in, but powerless to give out? What is required of an Empire is political differentiation, with the possession of an eager beating heart and a swift circulation pulsating through all its arteries.[2] With steam and electricity vibrating through the world, and annihilating space and time, oceans should unite rather than sunder an Empire.

And this thought brings us one step further. The sweep of that Empire should be known to all in the Island Home, or at least to those who aspire to be leaders in the State. The astounding ignorance of, and the languid indifference to, the resources, needs, and character of our Overseas Dominions and of those of our brothers and sisters who have lived there for one or more generations, and yet have turned their eyes lovingly to the Motherland, and rushed to her defence at the first breath of her peril—this ignorance and indifference are, in the opinion of the

[1] An old Greek proverb, which our classical friends will recognize. The Ox has weight, but little motion. So have some Government departments.

[2] Has not the Premier of Australia lately taught us a little of this Imperial thrill?

writers, among the most disquieting and disintegrating factors in the future solution of the Imperial Problem.

To knit together our Empire, we must first visualize it. Insular Britons ought to know how Canada and Australia educate their children; how they build their houses and cities; how industries and agriculture are faring Overseas; how men there—stern-faced men who have faced the rugosities of Mother Earth, and who are not engirded with the affected airs and graces of an artificial life pillowed on pleasure and propped by luxury—how such men govern and protect themselves. This war has brought them here. They have seen us face to face. Nothing then would have a greater and a more uplifting force than for a troop of Islanders from the Motherland to return the visit of our brothers-in-arms from Overseas—and that continually, when peace once more returns.

The visitor from these Islands would learn many things, and have his eyes opened to many crying evils at home in which now he acquiesces, but the enormity of which he would then be brought to realize. If English landlords and corporations could see some of the town plannings in the great cities of Canada and Australia, there would be an end to our own fossilized ideas as to the proper way to house a working man, and there would be a quicker sweep made of the shameful tenements, which now make bestial the lives of the sons and daughters of poverty and toil.

If, in their turn, some of the finer spirits from the new countries would stay on for a while after the war, and study the examples of our excellent town governments in the Motherland, they too on their return Overseas would make shorter shrift of the pirates who steal public money from municipal tills.

In default, however, of any privately organized system having for its object the visit of leading men to the Overseas Dominions—and nothing but organized system is of any permanent value—it would be an excellent investment in the interests of the Empire, if an Imperial Parliament would agree to vote an annual sum, sufficient to defray the expenses of (say) 10,000 selected young men from Great Britain, qualified by education and character, on an Overseas Expedition, embracing Canada, South Africa, Australia, and New Zealand—this expedition to include six weeks' stay in each Dominion and to cover the term of a scholastic year—(say) ten months in all. Let these selected men pay earnest money of £5—£10, and be conveyed in Inter-Empire steamships, retained for special service by the Imperial Parliament. A proportionate number of student-voyagers from each of the Overseas Dominions might be sent here on similar conditions, with similar results of Imperial consequence.

Such a proposal is not so Utopian as it might at first sight appear. It was propounded four or five years ago as a development of what was known as the Inter-Scholarship Scheme, on which one of the present writers was consulted, and in which he took a certain share.

But the pertinent question at once presents itself. Is it within the bounds of practical politics that a State Parliament sitting at Westminster, constituted as it is to-day, would ever lend its official sanction to such an Imperial "leap in the dark," depending as its members do for their political existence on the suffrages of the insular taxpayer? And how can that taxpayer, who naturally looks for a direct return for his money, be expected to pay for the development and preservation of that intangible

something called "Empire," if it presents no concrete image to his mind?

So then this question leads to the consideration of a far wider problem, the solution of which it is one of the indirect objects of this book to facilitate, since with it is intertwined the whole future of our industrial and commercial supremacy. It need hardly be said that we refer to the Federation of the Empire.

The Parliament sitting at Westminster preserves to-day the structure, and performs the duties, of a State—or purely British—Parliament, and, nevertheless, retains some of its original powers over the Governments Overseas.[1] Its character is provincial and it is provincially elected; so that while its professed attitude is Imperial, it is not surprising in the least that it seldom thinks Imperially. From an Imperial standpoint it is in a state of suspended animation, and has, for reasons which space forbids us to follow up, gone to sleep for twenty-three years.[2]

But the events of the Boer War (1899-1902) and of the present international struggle have shown it to be quite impossible that the present anomalous condition can continue. The magnificent response of her Children Overseas to the cry of the Motherland makes a permanent return to the old order not only intolerable, but dangerous to the integrity of the Empire.

The present Imperialistic system under which a single Sovereign State rules the rest must be swept away, and a

[1] See *The Empire on the Anvil*, by W. B. Worsfold, p. 10.

[2] The Imperial Federation League was founded in 1884 and dissolved in 1893, principally on account of the *non possumus* of two successive Prime Ministers.

Federal system must take its place. The Motherland at present numbers three-quarters of the white people of the Empire; the Overseas only one-quarter. But every year the respective populations approximate more nearly to equality. Having regard to the tide of emigration which will set in after the War, the white men of Canada, Australia, New Zealand, South Africa, will, in twenty years, outnumber those in the Motherland, which in area is only one-sixteenth of her own vast Dominions. As regards population, the United Kingdom has only 45 millions, and yet dominates 400 millions—almost a fourth part of all the nations on the face of the globe.

What have been and are the hindrances to Federation, which the late Secretary of the Colonies, Mr. Joseph Chamberlain, made it the latter part of his life-mission to sweep away? Chiefly these two:—

1. The refusal of the Parliament in the Motherland to grant a preference to the commodities imported into her ports from the Overseas Dominions. In other words, the Parliament of the United Kingdom has not shown itself willing to abandon the economic principles of the last half-century. It has hitherto declined to put a tariff on food stuffs and the imports of foreigners, although the imposition of such a tariff would confessedly have encouraged the exploitation of the natural resources of our own kith and kin under its Sovereign Rule, and would have ensured the more rapid development of populations and of industries Overseas. The Daughter-Lands, on their part, have not been prepared hitherto to agree to any complete scheme of Federation, except one based on the reversal of the economic policy which still holds sway in the Motherland.

2. Having gained their charter of autonomous government, the Dominions have naturally hesitated to enter into any *permanent* undertaking to contribute to the support of an Imperial Army and Navy, or to respond financially to other Imperial calls as long as they are not represented in an Imperial Parliament, which alone could have power to enforce decrees regarding Peace and War, and the interchange of Customs.

And yet, notwithstanding the fact that we in Great Britain have failed to grasp their outstretched hands, the War has produced the most splendid tribute from the Daughter-Lands both in blood and financial sacrifices ever known in the history of the world.

If then it be proved true that England will never be the same England again, in a far greater sense must it be true that the Empire cannot, and must not ever be, the same Empire as before. No longer must it remain an amorphous, illogical, unwieldy product of compromise, but, if it is to survive as an Empire, and not as a mere loose collocation of States cemented by the sentiment of common blood and common language, it must become one complete organic whole, welded together in all its parts, economically, as well as politically. Thus, and thus only can the Empire fulfil her high destiny—thus and thus only can Great Britain Limited develop into Great Britain Unlimited, in the most practical and Imperial acceptation of the word.

CHAPTER XIV

THE APPEAL

FELLOW-COUNTRYMEN, this book sounds in your ears a trumpet call to awake and put on strength. Face its unpleasant facts, and fight them. The war, which has robbed us of many of our best, has, at the same time, in the course of its blood-letting, reduced, for the time at least, the plethoric condition of the body politic. We have much for which to thank the Kaiser. "World-power or Downfall," and the blood it has spilled, have cemented the British Empire as nothing else could have done. Hence our great opportunity—perhaps the last.

After the final defeat of absolutism, three democracies are likely to guide the political destinies of the world—Great Britain with her Empire, France with her Colonies, and the United States with her Monroe Doctrine. If we are to rise to the greatness of our opportunities, some remedies must be applied, and those promptly, to the weak places exposed in these pages.

The end of the war will only be the beginning of strife. Most thinking men foresee that the next thirty years will be a generation of unrest all over the world. Let us be ready to face the coming problems with an iron will, a steady courage, as well as with an absolute freedom from prejudice.

A young nation, like a young man, accepts and assimilates changes readily. An old nation, wrinkled with

antiquity, is apt to resent organic reform, as heading straight for revolution. Hence the great difficulty of our task.

Yet it is something hardly short of revolution that our people need to-day—revolution in their social, political, economic, commercial, and industrial outlook—and, above all, in their educational system.

This book sends a message to every man, not only to confront all these inevitable changes with courage, but also to promote them with ardour. Like Roosevelt, we preach the doctrine of the strenuous life, the life of toil and effort, of labour and strife; we preach that the highest form of success comes, not to the man who desires more easy peace, but to the man who does not shrink from danger, from hardship, and from bitter toil, and who thus wins ultimate triumph. A life of that peace which springs merely from lack either of desire or of power to strive after great things is as little worthy of a nation as of an individual.

The facts which are set forth in this book and glossary form stern evidence that Great Britain, once the workshop of the world, has been drifting.

We are the heirs and the trustees of the greatest Empire in the annals of the world. Let not this be a mere phrase to us and nothing more. Our fellow-citizens in this Imperial heritage have proved, by evidence which can never be blotted out from the page of history, all that this has meant to them.

Let us prove that we too are worthy partakers of this World-Empire, by drawing more closely together the ties which unite us to our Brothers Overseas.

PART III

GLOSSARY

INTRODUCTION

OUR object in presenting the facts set forth in the following pages is to demonstrate the truth of this postulate:

That during the last 20-40 years most of the inventions, new ideas, and developments, have been given to the world by countries other than our own; furthermore, that their value has been more quickly appreciated and put to practical use in foreign lands.

If our facts and figures prove this general truth, as we maintain that they do, a reason must be forthcoming.

In our judgment that reason is to be found in the absence of a scientific education among the young in all grades and conditions in this country, and to this fact is due the failure to produce in our people at large a scientific habit of mind. Other contributory causes have doubtless led to our inability to maintain pre-eminence in the world of industry. But our educational system, or want of system, is the root cause.

We have attempted to produce evidence which should cover a range of subjects sufficiently wide as to be practically conclusive. Many additions could have been made, but enough for our purpose has been set forth in this book.

One hope—one plea—is urged. Let every reader apply himself to a study of the scope and inner meaning of the extraordinary revelations contained in the following pages. Let him, in respect of his own particular sphere of activity, ask himself dispassionately, or ascertain from others, whether our postulate is true. We entertain no doubt whatever as to the general conclusion at which he will arrive.

We have asked men engaged in the various industries under review to state in their own way whether our postulate is true

of their own particular industry or not. Our evidence then, as has been already said, is not gathered from museums and encyclopædias, but from practical men. It will be noted that, until other nations developed the scientific method in industry and affairs, we were the chief inventors and pioneers—that is, so long as all peoples relied upon the empirical method.

The inference to be drawn is that the British race possessed the most inventive genius of all peoples. On the other hand, untrained and uninstructed, or rather, with inferior training and instruction, it cannot rival other nations enjoying better educational advantages. The deduction is obvious. If we can bring ourselves as a nation to submit to the necessary mental training, and to adopt the painstaking methods of the foreigner in research work, it is certain that we shall again lead the world. We possess scientists of as great, or greater, eminence than most other countries, but their abilities are more or less lost, because they lack an appreciative audience—both in the Government and among the people generally.

It will be observed that we have refrained from dealing with some industries—notably the chemical industry, dyes, the Birmingham and Sheffield light trades, etc.; also other matters of interest, such as Military Science, Weapons of War, etc.

In the case of the industries named the facts have been made so widely known by the Daily Press that their repetition would serve no useful purpose. As regards Military Science, Weapons of War, etc., the times are obviously not propitious for their treatment.

Finally it is desirable to point out that many of our contributors have ventured their own opinions as to causes and remedies in various spheres of industry. The writers, while agreeing in many cases, do not hold themselves responsible for all the views expressed. The facts are the material things. In some cases the contributors to this Glossary have been willing to allow us to insert their names, and we have done so; others have preferred to remain anonymous, and consequently their names do not appear. All of them, however, vouch for the accuracy of the statements made. We again wish to thank all contributors for the very valuable help they have given to us, and for their collaboration.

We begin with an article on "Great Britain's Industrial Inefficiency," this being, in our opinion, the inevitable outcome of the facts and figures set forth in the Glossary.

GREAT BRITAIN'S INDUSTRIAL INEFFICIENCY

§ 1 The Facts

THE war has glaringly disclosed Great Britain's military unpreparedness and inefficiency. These appear particularly striking if compared with Germany's preparedness and efficiency. War possesses many of the characteristics of modern industry in its most perfect form. In order to be pursued with success it requires the highest directive ability on the part of the leaders, the most perfect organization, complete unity of effort, the fullest use of science, and the employment of the most perfect mechanical contrivances of every kind. Monster guns and quick-firers are, rightly considered, as much labour-saving machines as are steam hammers and power looms. Military and industrial efficiency are apt to go hand-in-hand. They are the fruits of the same tree.

Great Britain's performance in the war, especially in the beginning, was disappointing. Officers and men were animated by the greatest courage. However, heroism is unavailing against modern science, modern weapons, and modern organization. The stern logic of facts has taught us that modern war can be pursued with success only by a well-led and perfectly organized nation, in which science, leadership, and co-operation have been developed to the highest degree. Slowly and painfully the whole nation has been organized for war. The most perfect weapons and appliances had to be manufactured or imported from abroad. To the dismay of all those who believed that industrially Great Britain was the foremost nation in the world, it was found that this country was terribly deficient in the most important and the most scientific weapons and appliances, and that the making of these could not easily be improvised because Great Britain did not possess the necessary facilities, because science and the most perfect organization had been neglected in the past. Not only did we possess no Zeppelins and practically no guns wherewith to fight them, but owing to the inferiority of our scientific industries, particularly the iron and steel industries, the chemical industry, the electrical industry, the glass industry, etc., we were gravely handicapped in producing modern heavy guns and quick-

firers, shells, explosives, surgical apparatus, telescopes, field glasses, medicaments of every kind, etc. The slowness and the difficulty with which Great Britain provided herself with a sufficiency of modern arms and explosives, and with prismatic glasses, dyes and the innumerable chemicals which hitherto had been imported from Germany, have shown that Great Britain is not only militarily, but also industrially, far behind the times. The war has disclosed, even to the blindest, Great Britain's industrial inefficiency, especially in the most perfect, the most scientific, and the most modern industries.

Those who believe that Great Britain is still the foremost industrial country in the world may argue that Germany is superior to Great Britain only in those industries which are connected with war, that England excels in the arts of peace, that the British cotton and ship-building industries are superior to the German. Careful investigation, however, will show that Great Britain has not preserved that great industrial superiority which she possessed in the past, that in practically all industries she has fallen behindhand, that British industries, generally speaking, are inefficient.

Efficiency is a matter of comparison. If we wish to discover whether the British industries in general are efficient or not, it is useless to look to the past and to show that they have progressed, that the industrial processes employed at present are superior to those which formerly obtained, that our exports and imports have increased, etc. We can ascertain whether our industries are efficient or not only by comparing them with those possessed by the most efficient industrial nations, Germany and the United States.

It is easiest to compare the industries of nations by means of the industrial censuses, which give invaluable data for the national industries as a whole. Unfortunately, it is not easy to compare British and German production by means of these censuses, because the Censuses of Production issued by the two countries differ so much in character and in the classification of industries, that an analytical comparison is practically impossible. As, however, the British and American Censuses of Production give many comparable data, let us compare the British with the American industries by means of the official figures available. Such a comparison will show that the British industries are incredibly inefficient, that the American workers produce from two to three times as much as

do their British colleagues engaged in the identical employments.

The British Census of Production was taken in 1907 and was published in 1912 as a Blue Book numbered 6320. It may be obtained for 7s. 6d. The last American Census of Production was taken by the American Government in 1909. The two years 1907 and 1909 lie so closely together that we can fairly compare the results given. There is a difficulty in comparing the efficiency of British and American industries by means of the census figures. The British and American authorities have in many instances classified the national industries according to different methods. Hence there is only a limited number of industries available for which comparable figures exist. A full list of these comparable figures will be found in the Appendix, to which the particular attention of the reader is called.

This list was published in the *Fortnightly Review* for August, 1913, in an article written by J. Ellis Barker which attracted much attention at the time. The startling figures given in it were much discussed in commercial, industrial and technical circles and in the Press, but hitherto they have not been successfully challenged. The Tables in Section 4 have been reprinted with the permission of the Editors of the *Fortnightly Review* and the *Nineteenth Century and After*.

The comparisons given apply to twenty-six industries, such as the making of boots and shoes, cardboard boxes, butter and cheese, cement, clothing, cocoa, chocolate and confectionery, cotton goods, clocks and watches, cutlery and tools, etc. The first column of the table gives the value at wholesale prices of the entire production per year of the various industries named. The second column indicates the number of wage-earners engaged in the various industries. By dividing the production per year by the number of wage-earners engaged in the various industries, we arrive at the value of production per wage-earner per year, which will be found in the last column.

Comparison of the industrial production per wage-earner per year in the United States and in the United Kingdom shows that in most cases production per head is from two to three times as great in the United States as in the United Kingdom. While, for instance, in the boot and shoe industry an English worker produced £171 worth of goods per year, his American competitor produced no less than £516 worth of goods, or three times as much. In cardboard boxes, the yearly production per wage-earner was £106 in the United Kingdom,

and £275 in the United States. In this instance we find that for every £1 worth of goods produced by the British worker the American worker produced £2 15s. worth. The next item on the list is butter and cheese. Here we find the production per worker given as £1,310 in the United Kingdom, and £2,979 in the United States. In that industry production per man is considerably more than twice as great in the United States as in the United Kingdom. In cement, the production per man per year is £192 in the United Kingdom and £472 in the United States, or 2½ times as much. For every £1 worth of cement produced by the British worker, the American worker produced about £2 10s. worth. In clothing, British production is £158 per worker per year and American production £484 per worker per year, or somewhat more than three times as large as that of the British worker. Many further comparisons will be found in the list in the Appendix to which again attention is drawn.

The comparisons given are truly startling. They are so startling that many will no doubt suspect that the figures supplied are incorrect. Statistics are of course never absolutely, but only approximately, correct. In statistics, as in all other things, errors occur. It may, however, be claimed that the figures given can, in the main, be relied upon. Of course it must be borne in mind that the qualities of American and British goods are not always identical. English clothes and American clothes, English boots and American boots, English cement and American cement differ in quality, and so do all the items in the long list given in the Appendix. In some instances the English quality may be superior, and in others inferior. On the whole, the twenty-six trades enumerated may in fairness be compared.

It may be argued that American production per man in the twenty-six important trades given is only apparently but not really greater than British production, because American prices are higher. At first sight that objection seems reasonable. It should, however, be noted that the prices given are not retail prices, but wholesale prices. American wholesale prices, like British, are constantly fluctuating. That makes comparison difficult. Still, on the whole, British and American wholesale prices in the trades enumerated are not dissimilar. It should be noted that many articles which are identical in the two countries, such as iron and steel, standard

cotton cloths, etc., have so similar a price that sometimes the American produce and sometimes the English is a little cheaper. The fact that American and British wholesale prices are very similar is evident from this, that large quantities of American manufactured goods are sold in free competition with similar British goods in neutral markets, and even in the United Kingdom. If American wholesale prices, generally speaking, were much higher than British, American manufactured goods could not be sold in competition with British, except at a loss. It is of course out of the question that American clothes, boots, cement, etc., are (wholesale) two or three times as expensive as the corresponding British productions. Consequently it is obvious that American production per worker per year is far superior to British. While American and British wholesale prices are apparently very similar, American retail prices are in many instances much higher than are British. This is only natural. The vastness of the United States adds greatly to the cost of sending travellers about, forwarding goods, etc. Besides, the wages of American shop assistants are much higher than are British. These higher expenses in retailing find their expression in higher retail prices. Hence goods, which (wholesale) are as cheap in America as in England, are considerably dearer than in England, if bought at an American retail shop.

While most American industries produce per man per year from two to three times as much as do the corresponding British industries, there are some British industries which are comparatively efficient. These are the cotton industry, the printing and publishing industry, the railway carriage and wagon industries, etc. In cotton goods, production per worker per year is £236 in the United Kingdom and £332 in the United States. In this instance, production per worker is only about 40 per cent. larger in the United States than it is in England. In printing and publishing, British production per worker per year came to £396, and American to £572. In railway carriages and wagons, British production per worker per year came to £364, and American to £574. In these two industries the American workers produce per head only about 50 per cent. more than do their British colleagues.

The United States are far ahead of the United Kingdom not only in manufacturing efficiency, but in mining efficiency as well. This will be seen from the most interesting table,

"Coal production per annum per person employed," which also will be found in the Appendix, and which has been extracted from the Board of Trade publication, *Coal Tables,* published in March, 1914. From that table it appears that coal production per annum per worker in the United Kingdom *decreased* from 312 tons in 1886-90 to 260 tons in 1911, and to 244 tons in 1912, the year of the great strike. In the United States, on the other hand, coal production *increased* from 400 tons per worker per year in 1886-90 to 613 tons in 1911, and to 660 tons in 1912. In other words, in coal mining, as in manufacturing, the American worker produces from two to three times as much per year as does his British colleague.

Of course, in many cases, the British coal seams cannot be worked as easily as the American. Coal often occurs at greater depth and in thinner layers in Great Britain than in the United States. However, as machinery has been greatly improved during the last twenty or thirty years, British coal production per head should also have improved. Yet we find that, whereas American coal production per head per year has increased by more than 50 per cent. during the period indicated, British coal production has greatly and continuously decreased.

The facts given show, as has been previously stated, that the American industries are far more efficient than the British. They show that, broadly speaking, the American workers produce per head per year from two to three times as much as their British colleagues, although there are certain trades which form an exception, for in some the difference in favour of the American workers is less startling. In Section 2, it will be shown why American production per worker per year is so much greater than British, or in other words, why the British industries are so very inefficient if compared with the American; and it will also be shown why certain British industries, such as the cotton industry, the printing industry, etc., compare more favourably with the corresponding American industries than do the British industries in general.

§ 2 The Causes

It has already been shown that the British industries are very inefficient if compared with the corresponding American in-

dustries, that, generally speaking, the American workers employed in the factories and in coal mines produce from two to three times as much per year as do their British colleagues. The question naturally suggests itself: Why is production per man from two to three times as great in the United States as it is in the United Kingdom? There are various causes for this extraordinary difference, but the principal cause will be revealed by the important table, "Industrial Production in the United States and in the United Kingdom," printed on p. 148 of the Appendix, to which attention is again called. The figures given are taken from the British and American Censuses of Production, and may be considered reliable.

The table, "Industrial Production in the United States and in the United Kingdom," summarizes and compares the position of twenty-six important British and American industries. It has five columns. The first column compares the output of the British and American industries. The second column gives the number of wage-earners employed by them. The third column indicates the amount of horse-power used by these industries, both in the United States and in the United Kingdom. The fourth column indicates how much horse-power is available per 1,000 workers in the various industries of the two countries, and the fifth column gives the value of production per wage-earner per year, for each industry in the United States and in the United Kingdom.

By comparing the number of wage-earners given in the second column with the amount of horse-power given in the third column, we may find how much horse-power per 1,000 workers is available in the different American industries and in the corresponding British industries. Every reader can thus check for himself the fourth column of the table, entitled "Horse-power per 1,000 wage-earners." Comparison of production per man and of the horse-power employed per 1,000 wage-earners in the United States and in the United Kingdom shows a curious coincidence. We find that almost invariably America's great superiority in production per wage-earner per year is accompanied by a similarly extraordinary superiority in horse-power employed per 1,000 workers. In boots and shoes, for instance, American production per worker is three times as great as is British production, and American horse-power per 1,000 workers is also three times as great as is

British horse-power per 1,000 workers, the actual figures being as follows:

	Production per year.	Number of Wage-earners.	Horse-Power Employed.	Horse-Power per 1,000 Wage-earners.	Value of Production per Wage-earner per year.
Boots and Shoes.	£				£
United Kingdom	20,095,000	117,565	20,171	172	171
United States ..	102,359,000	198,297	96,302	486	516

If we glance through the whole of the table in the Appendix, we find that per 1,000 workers the horse-power employed is on an average about three times as great in America as in this country.

It is obvious that a man who employs a power loom or a steam shovel can do infinitely more work per year than an equally industrious man who uses an ordinary shovel or a hand loom. It is equally obvious, and hardly needs proving, that an American worker engaged in the same industry can easily produce three times as large a quantity of goods as his British colleague. The explanation of the curious phenomenon, that American workers produce as a whole from two to three times as much per year as do British workers engaged in the same industries, is therefore very simple. It is due to the greater employment of machinery in America, to greater mechanical efficiency.

We live in the age of machinery. It is a well-known fact that the Americans are far ahead of Englishmen in the employment of labour-saving machinery of every kind. In this mechanical age of ours, industrial production depends more on engine-power than on man-power. Now the American workers employ not only from two to three times as much horse-power as do the British workers, but use at the same time, in many industries, more perfect and therefore more productive machinery and processes. It follows that America's industrial efficiency should be at least three times as great as British industrial efficiency, especially if better and more powerful machinery should be backed by more perfect organization, by production on a larger scale, and by a more intensive use of science.

While, generally speaking, the American workers produce

per year from two to three times as much as do their British colleagues, there are, as has been stated in Section 1, some British industries, such as the cotton industry, printing and publishing, etc., which compare more favourably with the American industries. The greater efficiency of some British industries is due to the fact that they are less inferior in engine-power to the corresponding American industries than are most British industries. In the cotton industry, for instance, in which the American worker produces 40 per cent. more per year than the British worker, there is 2,214 horse-power per 1,000 workers in the United Kingdom and 3,423 horse-power in the United States. A superiority of 40 per cent. in American production is accompanied by a superiority of about 60 per cent. in horse-power.

America employs, as has been previously stated, not only more power per worker, but also more perfect machinery than does the United Kingdom. As it would lead too far to compare the outfit of the American and British industries in detail, let us glance only at the most important British manufacturing industry, the gigantic cotton industry. In 1912 the United States Tariff Board published on behalf of the American Government a report on cotton manufacturers, in which we read:

"English manufacturers make little use of automatic looms, of which there were less than 6,000 in May, 1911, in the whole of England, while in the United States there are well over 200,000. It is estimated that there are now about 10,000 of these looms in use in England, and about 15,000 on the Continent. Where automatic looms can be used, a single weaver commonly tends twenty looms, and sometimes as many as twenty-eight. . . . Several reasons are advanced for the delay in the more general adoption of the automatic loom in England. . . . For one thing, the automatic loom costs about two and a half times the ordinary plain loom, and this has deterred many English mills already equipped with plain looms from adopting them. . . . An additional reason for the limited use of the automatic looms appears to be the objection to them of the labour unions, which have been afraid that they would be used to displace labour and to throw more work on the weaver without proportionately increasing his earnings."

This important report shows that but a few years ago the American cotton industry was far ahead of the British in the

use of the most modern and most perfect labour-saving machinery. In many other British industries similar conditions prevail.

The great superiority of American coal production per worker per year over British coal production is due partly to superior machinery used in the United States, partly to the restriction of output on the part of English miners. Hence the yearly production of coal per worker has considerably *decreased* in the United Kingdom during the last twenty or thirty years, while it has *greatly increased* not only in the United States, but in the British Dominions as well. This is apparent from the table, "Coal Production," which will be found in the Appendix on p. 150.

Readers will naturally ask: Why do the American industries possess more and better machinery than the English? Why has England allowed herself to be outpaced in industrial efficiency?

England's inferiority is due to general conditions, to the employers, and to the workers. The United States are, and always have been, a high-wage country, wages being two or three times as high as in England. American manufacturers could not possibly compete with British manufacturers, even when protected by a Tariff, unless their workers produced two or three times as much per year as do British workers, for only thus could American costs of production and American prices be made to approximate to British cost of production and British prices. Besides, British employers have not kept abreast of the times. Many were over-conservative and indifferent to progress. These were satisfied to continue working with old-fashioned or insufficient machinery. Others who wished to introduce improved machinery were prevented by the workers. While most American workers see in the labour-saving machinery a friend, many British workers see in it an enemy, believing that improved machinery, by greatly increasing output, will throw many workers out of work. Animated by that idea, many British workers have opposed the introduction of improved machinery. They have unwisely pursued a policy of conservatism in a progressive world. The idea that the machine is the enemy of the worker has been believed by the short-sighted of all ages. Greater production per man cheapens manufacture, and the cheapening of goods increases the demand for them, and thereby increases the comfort

of the people. Had the hostility to labour-saving machines on the part of the workers been successful from the first, we should still be in the stone age.

It is universally known that the industrial inefficiency of Great Britain is due partly to the conservatism of employers and partly to the restrictive policy of organized labour. In a Report entitled "Regulation and Restriction of Labour," published by the United States Department of Commerce and Labour, we read :—

"Perhaps the most significant fact brought about by this investigation is the striking difference between . . . Great Britain and the United States. . . . In Great Britain the justification of vested rights is avowed, and shows itself strongly in the dislike of capitalists to discard old and out-of-date machinery and methods of business, and in the obstacles placed by unionists in the way of machinery and division of labour, which tend to eliminate their acquired skill. . . .

"One can readily understand how difficult it is to make any change whatever in the English engineering industry. Each party knows exactly what it is getting when working on traditional lines with traditional machinery and old methods. The working man is afraid that, if any change, however slight, is made, his pay per unit of effort will be lowered. On the other hand, the employer is afraid that any proposed change of whatever nature will result in friction and controversy with his workmen. He fears that, should he reorganize his shop with expensive and more modern machinery, his employees would either refuse to work the new machines or, not being familiar with the power of the machinery, would demand a rate of pay which would more than absorb the profits from its use, or, suspecting that they were not getting a sufficient rate of pay on the machine, would restrict the output so as to make the venture unprofitable. Although this deadlock condition is a genuine restriction of output, and one fraught with great dangers to the future of the country, it is not a restriction that can be stated statistically. It is hoped however to give a sufficient illustration of the way in which actual controversies have arisen in the last few years to make it plain that the English engineering industry is very much below the highest possible efficiency, and that under present conditions English working men are turning out very much less product than they are capable of doing without any injury whatever to their health or to the social welfare."

In an important German technical handbook, *Gemeinfassliche Darstellung des Eisenhuttenwesens*, Dusseldorf, 1912, which deals with the German iron and steel industry we read :—

" The German Trade Unions, with their Socialist ideas, are opposed to progress. If their aspirations should succeed, the German iron industry would be ruined. An attempt on the part of the German Trade Unions to increase the earnings of the skilled workers by limiting the number of apprentices, in imitation of the policy which has been followed by the British Trade Unions, would produce a scarcity of skilled workers in Germany, as it has done in England. The British iron industry should be to us Germans a warning example. The English Trade Unions, with their shortsighted championship of labour, with their notorious policy of ' ca' canny ' (the limitation of output), and with their hostility to technical improvements, have seriously shaken the powerful position of the British iron trade."

Unfortunately British industries are inferior to American, not only in mechanical output, but also in organization. Production is cheapened and perfected by a scientific division of labour, by production on a large scale. A large factory which produces a single commodity can turn it out far more perfectly and far more cheaply than a small factory which turns out a number of different commodities. Besides, a number of small factories want many sets of directors, accountants, travellers, etc., and they engage among themselves in unnecessary and suicidal competition. Scientific production is very expensive. It requires a large staff of highly trained men such as engineers, analytical chemists, etc. If we look around, we find that the most successful industries are those in which organization is the most perfect, and the most perfect organization can be obtained only in the case of enormous industries, in the case of nation-wide industries which are under a single control. The English house of J. & P. Coats & Co., The United States Steel Corporation, and the huge electrical, chemical, and iron combines of Germany may serve as models of efficiency. There is a great prejudice in this country against trusts and combines. Manufacturers can combine, either for the purpose of increasing efficiency, or for that of exploiting the public. The former is wholly beneficial to the industries and to the nation as a whole. Legislation should not oppose the creation of combines, unless they are obviously harmful to the nation. The London and North-Western Railway is a combination of numerous formerly independent lines. The efficiency of that railroad has been greatly increased by their amalgamation into a single one. Industrial nation-wide co-operation can be created only when

wasteful and unnecessary competition, and the equally wasteful and unnecessary duplication of directorates, machinery, etc., are abolished.

Industries, like armies, to be most efficient, must embrace the whole nation, and like armies, they must be directed by men of the highest ability. The British industries have suffered, not only through an inferior mechanical equipment, inferior organization, and lack of nation-wide co-operation, but also through inferior leadership. Many of the most eminent manufacturers have not taken business efficiency seriously. Only with the best leadership, the most perfect organization, and the most perfect mechanical outfit, can Great Britain recover the industrial pre-eminence which she possessed in the past.

§ 3 The Consequences

In Sections 1 and 2 we have seen that the British industries are extremely inefficient if compared with competing industries in the United States, and we have seen that this inefficiency is due to the fact that this country is inferior to the United States in machinery, organization, etc. It will be clear to the reader that the American workers engaged in the manufacturing industries and in coal mining produce from two to three times as much per year as do their British colleagues engaged in the identical occupations. Let us now inquire into the consequences of the comparatively small output per worker in this country. British industrial inefficiency and under production affects the rich and the poor, the classes and the masses, the manufacturers, the traders and the workers. As the workers are the largest body of people, let us consider in the first place how they are affected by British industrial inefficiency.

All social investigators who have studied the conditions under which the British people live have been amazed at the poverty of a very large percentage of the population. The late Sir Henry Campbell Bannerman made the famous statement, "There are about 30 per cent. of our population underpaid, on the verge of hunger." The Rt. Hon. Sir Charles Booth, who investigated during many years the labour conditions of London, found that 30.7 per cent. of its inhabitants were living in poverty. Mr. Rowntree wrote, in his well-known book, *Poverty*, regarding the city of York :—

"Allowing for broken time, the average wage for labour in York is from 18s. to 21s., whereas the minimum expenditure necessary to maintain in a state of physical efficiency a family of two adults and three children is 21s. 8d., or, if there are four children, the sum required would be 26s. It is thus seen that the wages paid for unskilled labour in York are insufficient to provide food, shelter, and clothing, adequate to maintain a family of moderate size in a state of bare physical efficiency. The above estimates of necessary minimum expenditure are based upon the assumption that the diet is even less generous than that allowed to able-bodied paupers in the York workhouse, and that *no allowance is made for any expenditure other than that absolutely required for the maintenance of merely physical efficiency*. 27.84 per cent. of the people of York are living in poverty."

The italics are the author's own. Lady Bell, who made an investigation into the labour conditions prevailing among the workers in the very important iron centre of Middlesborough, wrote in her book, *At the Works*:—

"Out of the nine hundred houses carefully investigated, one hundred and twenty-five in round numbers were found to be absolutely poor. The people living in them never have enough to spend on food to keep themselves sufficiently nourished, enough to spend on clothes to protect their bodies adequately, enough to spend on their houses to acquire a moderate degree of comfort. One hundred and seventy-five more were so near the poverty line that they are constantly passing over it. That is, the life of one-third of these workers whom we are considering is an unending struggle from day to day to keep abreast of the most ordinary, the simplest, the essential needs."

Mr. Sidney Webb stated before the Conference of the National Anti-Sweating League in 1907: "In the United Kingdom at least 8,000,000 of the people are at the present time existing under conditions represented by adult male earnings of less than £1 per week."

Messrs. Cadbury and Shann wrote in their book, *Sweating*:—

"The average wage of an unskilled labourer in this country is from 17s. 6d. to £1 per week, so that, even with regular work, such a man cannot keep himself and his family above the poverty line. And very few unskilled labourers get regular work. Generally in the United Kingdom, an unskilled labourer does not obtain a wage to enable him to keep himself and family in a state of efficiency—that is, he is a sweated worker."

In the United Kingdom there were before the war numerous badly paid workers, while others received high or very high wages. Those who received high wages were skilled workers, were men who produced with their tools, or with machinery, considerable values. The badly paid workers on the other hand were unskilled, and produced per head comparatively little. High and low wages are determined mainly, not by the generosity or meanness of employers, but by the value of the work done by the workers themselves. The Trade Unions can of course regulate wages to some extent. However, they cannot possibly provide a high wage for a worker who produces goods of small value. It is generally known that American wages are from two to three times as high as are British wages. They are so very much higher than British wages because American production per man is from two to three times as great as is British production, as has been shown in Sections 1 and 2.

The British and American Censuses of Production supply not only the value of production for a large number of industries, but they give at the same time the so-called overhead expenses of factories, and state the value of the raw material used in manufacturing. We are thus enabled to discover, not only the value of the goods produced by entire industries and the value of the goods produced per worker per year, but we also discover the actual value of the work done by every worker. For instance, if a worker produces per week £5 worth of goods, let us say boots, we can discover the value of his weekly labour by deducting from that sum the price of the leather, etc., used, and the general factory expenditure per worker per week. If the leather employed in the making of the boots costs £3, and the general factory expenditure per worker per week came to 10s., we find that the average worker produces by his work a value of 30s. per week. Out of this sum the manufacturer pays a wage to the worker, and appropriates something for himself—his profit. Now if a worker produces no more than 30s. by his weekly labour, he can evidently not possibly earn more than 30s. however the profits are distributed. If the manufacturer worked without a profit, giving his labour gratis, or if socialism were introduced, a worker producing no more than 30s. by the work of his hands could obtain no more than that sum per week. That must be obvious to all who give the matter a moment's thought. If, on the other hand, the

worker should produce three times as much by means of greatly improved machinery, there would be a sum of 90s. per week available for paying his wage and a profit to the manufacturer, and there is no reason why both the manufacturer's profit and the worker's wage should not be trebled, provided, of course, the trebled output of boots can be sold. If, on the other hand, the worker should halve the production, the manufacturer could not possibly pay him more than 15s. per week.

Low industrial production per head is mainly responsible for low wages in Great Britain, and high production per head has made possible high wages in the United States. In the Appendix on page 150 a table entitled "Net Produce per Worker per Week" will be found, which reveals to us why wages in the United Kingdom are low, and why they are high in the United States. In boots and shoes for instance, the British worker produces net per week, according to the Census of Production, only 27s. 4d., while his American colleague produces 70s. In cardboard boxes, the net production per worker comes to 20s. per week in the United Kingdom, and to 55s. per week in the United States.

It must be clear to all who give the matter a little thought that wages can be greatly increased only if production is greatly increased. Unfortunately many short-sighted men have preached that workers can benefit themselves most by producing as little as possible for the largest possible wage. Now, rightly considered, wage earners are paid not in money but in kind. What matters to the worker is not how many shillings per week he receives, but what his weekly wage will buy. If a worker earns £5 per week and cannot buy sufficient food and clothing with the money, he is much worse off than a worker in another country who receives only 15s. per week but can supply all his needs because goods are cheap and plentiful.

The nation is a great co-operative society. Some men make boots, some make clothes, some produce fuel and some raise food. The workers engaged in making boots, clothes, etc., get certain wages which they spend in buying boots and clothes, fuel and food. Now, if all the workers limit their output to the utmost, they may conceivably receive high wages, but there will be little food and fuel and few boots and clothes. There will be too few to go round, and the result will be that the workers are ill-clad and ill-nourished whatever their money

wages may be, for one cannot eat money. If, on the other hand, all the workers produce, with the help of the most perfect machinery, vast quantities of clothes, food, fuel, etc., the goods produced will have to be consumed, and they can be consumed only by the many. High production all round leads to great consumption all round. It makes clothing, food, fuel, etc., plentiful for the workers.

Great Britain suffers not from over-production but from under-consumption, and under-consumption in Great Britain is due to under-production. If the workers all round produced from two to three times as much as they are producing at present, they would not only double and treble their wages, but would spend twice and three times as much on clothing, food, fuel, amusements, etc., as do the American workers. From the official investigations which have been made it appears, for instance, that in 1909 the people of the United States bought £120,000,000 of cotton goods, whereas the British people bought only £20,000,000 worth. As there were, roughly speaking, twice as many people in the United States in that year as there were in the United Kingdom, it follows that the average family in America bought three times as many shirts, collars, handkerchiefs, etc., as did the average English family. Those who know America and the British Dominions well are aware that not only are wages from two to three times as high as they are in this country, but that the workers live far better than they live over here, that they are better dressed, better fed, and are able to put by substantial sums of money.

High production alone can raise wages very considerably, and high wages need not cause dearness. If the doubling and trebling of wages is accompanied by the doubling and trebling of production, the commodities made by high wages need not become any dearer. The result would be unbounded prosperity among the workers. A man who has to work now half a day in order to buy a pound of tea might then be able to buy it with a single hour of his labour.

Unfortunately many Trade Unions have tried to make commodities scarce and dear. That policy has been particularly noticeable in the coal trade. From the table, "Average Value of Coal per ton at the Pit's Mouth," given on page 151 of the Appendix, it will be seen that, largely owing to the policy of restricting output, British coal has increased in price from

4s. 10d. per ton in 1886 to 9s. 0¾d. per ton in 1912, *i.e.*, has almost doubled in price. During the same period American coal has fallen from 6s. 4¼d. per ton to 6s. 1d. per ton. It has decreased in price, and American coal was made considerably cheaper than British coal, although the American coal miners receive higher wages than do the British coal miners. In 1886 American coal was almost 50 per cent. dearer than British coal, but in 1912 British coal was about 50 per cent. dearer than American coal. Thus, all the British industries which use coal were deprived of the advantage of cheap coal by the miners, and the miners were deprived of the advantage of cheap manufactured goods by those workers in the factories who tried to benefit themselves by producing an artificial scarcity through restriction of output.

If we look round in the world, we invariably find that, where production per man is greatest and most perfect, there the masses and the classes are the most prosperous. In the United States where production per man is greatest, we find not only the richest millionaires, the richest manufacturers and the richest merchants, but also the richest workers. In India, on the other hand, where individual production is small, because little machinery is used, we find that the classes are poor. Manufacturers and traders obviously cannot become wealthy in a country where the masses are poor. The masses and the classes are therefore equally strongly interested in replacing the present inefficiency of the British industries by the highest possible efficiency, by increasing production to the utmost.

The goods produced will find their purchasers, chiefly in the home market. Well-paid working men would double and treble their purchases. It should not be thought that the doubling and trebling of the production need entail greater exertions on the part of the workers. In the most highly organized industries possessed of the most perfect machinery little hard work is done by men. The machines work harder and work quicker, and the more perfect machines require no greater exertion but only more intelligent guidance on the part of the workers. In America, generally speaking, working hours are shorter than in Great Britain, and work is less arduous. Of course, there are certain exceptions, but these only confirm the rule that work is easier and less exacting with the best labour-saving machinery than it is with inferior machinery.

§ 4 Appendix

	Production per year.	Number of Wage-earners.	Horse-Power Employed.	Horse-Power per 1,000 Wage-earners.	Value of Production per Wage-earner per year.
Boots and Shoes.	£				£
United Kingdom	20,095,000	117,565	20,171	172	171
United States ..	102,359,000	198,297	96,302	486	516
Cardboard Boxes.					
United Kingdom	2,067,000	19,844	2,288	114	106
United States ..	10,970,000	39,514	23,323	590	275
Butter and Cheese.					
United Kingdom	10,164,000	7,754	11,372	1,477	1,310
United States ..	54,911,000	18,431	101,379	5,507	2,979
Cement.					
United Kingdom	3,621,000	18,860	60,079	3,195	192
United States ..	12,641,000	26,775	371,799	13,873	472
Clothing.					
United Kingdom	62,169,000	392,084	17,837	45	158
United States ..	190,566,000	393,439	65,019	165	484
Cocoa, Chocolate and Confectionery.					
United Kingdom	16,171,000	54,629	19,898	346	296
United States ..	31,437,000	47,464	46,463	980	662
Cotton Goods.					
United Kingdom	132,000,000	559,573	1,239,212	2,214	236
United States ..	125,678,400	378,880	1,296,517	3,423	332
Clocks and Watches:					
United Kingdom	613,000	4,448	550	125	137
United States ..	7,039,400	23,857	14,957	628	296
Cutlery and Tools.					
United Kingdom	2,047,000	12,485	5,248	420	164
United States ..	10,653,200	32,996	68,294	2,069	323
Dyeing and Finishing Textiles.					
United Kingdom	18,000,000	97,588	190,252	1,949	184
United States ..	16,711,200	44,046	107,746	2,449	379
Gasworks.					
United Kingdom	20,844,000	49,413	33,618	687	422
United States ..	33,362,800	37,215	128,350	3,469	897
Firearms and Ammunition.					
United Kingdom	677,000	4,444	2,619	595	152
United States ..	6,822,400	14,715	17,840	1,214	464
Gloves.					
United Kingdom	1,056,000	4,532	509	113	233
United States ..	4,726,200	11,354	2,889	256	416

	Production per year.	Number of Wage-earners.	Horse-Power Employed.	Horse-Power per 1,000 Wage-earners.	Value of Production per Wage-earner per year.
Hats and Caps.	£				£
United Kingdom	5,256,000	28,420	5,142	181	149
United States ..	16,598,000	40,079	23,524	588	414
Hosiery.					
United Kingdom	8,792,000	47,687	7,784	163	184
United States ..	40,028,600	129,275	103,709	804	309
Leather, Tanning and Dressing.					
United Kingdom	18,289,000	26,668	22,609	847	686
United States ..	65,574,800	62,202	148,140	2,389	1,054
Lime.					
United Kingdom	2,184,000	15,532	10,867	701	141
United States ..	3,590,400	13,897	27,671	1,991	258
Brewing and Malting.					
United Kingdom	67,254,000	68,996	64,636	937	975
United States ..	82,616,400	56,339	347,726	6,209	1,466
Matches.					
United Kingdom	862,000	3,865	1,591	408	223
United States ..	2,270,600	3,631	6,224	1,729	625
Paint, Colours and Varnish.					
United Kingdom	9,127,000	10,574	14,575	1,375	863
United States ..	24,977,800	14,240	56,162	4,012	1,754
Paper.					
United Kingdom	13,621,000	40,955	172,224	4,201	330
United States ..	53,531,000	75,978	1,304,265	15,846	705
Pens and Pencils.					
United Kingdom	791,000	6,025	1,450	241	131
United States ..	2,539,000	6,058	4,261	710	419
Printing and Publishing.					
United Kingdom	13,548,000	34,210	38,611	1,133	396
United States ..	147,757,200	258,434	297,763	1,154	572
Railway Carriages and Wagons.					
United Kingdom	9,850,000	27,105	30,407	1,126	364
United States ..	24,746,000	43,086	97,797	2,274	574
Silk.					
United Kingdom	5,345,000	30,710	18,867	608	142
United States ..	39,382,400	99,037	97,947	989	398
Soap and Candles.					
United Kingdom	12,797,000	15,596	16,938	1,092	821
United States ..	22,897,600	13,538	29,159	2,160	1,691

TONS OF COAL PRODUCED PER ANNUM PER PERSON EMPLOYED

	United Kingdom.	United States.	Australia.	New Zealand.	Canada.
1886-90 ..	312	400	333	359	341
1891-5 ..	271	444	358	388	375
1896-1900 ..	298	494	426	441	457
1901-5 ..	281	543	437	474	495
1906-10 ..	275	596	462	470	439
1908 ..	271	538	500	478	422
1909 ..	266	617	388	456	400
1910 ..	257	618	449	478	453
1911 ..	260	613	485	487	395
1912 ..	244*	660	542	503	472

* Strike year.

NET PRODUCE PER WORKER PER WEEK

	In the United Kingdom. £ s. d.	In the United States. £ s. d.
Boots and shoes	1 7 4	3 10 0
Cardboard boxes	1 0 0	2 15 10
Butter and cheese	2 8 1	8 3 1
Cement	2 10 10	4 17 8
Clothing	1 3 11	4 7 4
Cocoa, chocolate and confectionery ..	1 12 3	4 18 5
Cotton goods	1 10 5	2 13 9
Clocks and watches	1 7 9	4 3 0
Cutlery and tools	1 8 1	4 1 6
Dyeing and finishing textiles	1 18 11	4 4 3
Gasworks	4 1 1	11 16 7
Firearms and ammunition	2 2 8	4 9 2
Gloves	1 11 2	3 10 9
Hats and caps	1 5 10	4 1 10
Hosiery	1 3 5	2 2 8
Leather tanning and dressing ..	2 5 0	4 13 1
Lime	1 13 5	3 2 4
Brewing and malting	6 7 3	19 10 5
Matches	1 13 0	7 3 1
Paint and varnish	3 16 2	12 9 3
Paper	2 2 8	5 3 5
Pens and pencils	1 9 8	4 5 9
Printing and publishing	3 13 1	7 16 11
Railway carriages, etc.	2 7 4	4 0 5
Silk	1 1 2	3 9 3
Soap and candles	2 19 8	11 7 8

AVERAGE VALUE OF COAL PER TON AT THE PIT'S MOUTH

	United Kingdom.	United States.	Australia.	New Zealand.
	s. d.	s. d.	s. d.	s. d.
1886	4 10	6 4¼	—	—
1887	4 9¾	6 6¼	9 2	10 10
1888	5 0¾	6 0	9 0	10 11
1889	6 4¼	5 3½	8 11	11 3
1890	8 3	5 2¾	8 6	11 0
1891	8 0	5 3½	8 9	11 4
1892	7 3¼	5 4¾	7 11	11 3
1893	6 9½	5 4	7 5	11 1
1894	6 8	5 1	6 8	11 0
1895	6 0½	4 9¼	6 4	11 1
1896	5 10¼	4 9¼	6 2	10 10
1897	5 11	4 7½	5 11	10 0
1898	6 4¼	4 5	5 9	10 0
1899	7 7	4 8½	6 1	10 0
1900	10 9¾	5 3¾	6 0	10 9
1901	9 4½	5 6½	7 7	11 0
1902	8 2¾	5 8¼	7 9	10 11
1903	7 8	6 7	7 4	10 9
1904	7 2½	5 10¾	6 10	10 9
1905	6 11½	5 8	6 2	10 7
1906	7 3½	5 9½	6 3	10 7
1907	9 0	5 11½	6 10	10 7
1908	8 11	5 11¾	7 4½	10 4½
1909	8 0¾	5 7½	7 6½	10 10½
1910	8 2¼	5 10¼	7 6½	11 1½
1911	8 1¾	5 10¾	7 5½	10 10½
1912	9 0¾	6 1	7 6½	10 11½

GENERAL COMMERCIAL SUBJECTS

§ 1 Scientific Management

By Herbert N. Casson

"Scientific Management" and "Efficiency" have in the past six or seven years acquired a new and almost technical meaning. "Scientific Management" means the application of exact methods of study and analysis to the various tasks of the industrial world; and "Efficiency" means the same thing.

in a more general way. "Scientific Management" refers especially to manufacturing, while "Efficiency" is a more general term, referring to any human activity, either of work or play.

The new methods, to which these words refer, have been developed wholly in the United States. They were worked out by two separate groups of men, the one group led by the late F. W. Taylor, of Philadelphia, and the other by Harrington Emerson, of New York. These groups worked harmoniously together, exchanging data, and in some cases combining to accomplish a particular task. These groups were composed of two or three German-Americans, several Canadians and a dozen or more English-Americans.

The central ideas of "Scientific Management" were unquestionably originated by F. W. Taylor. He was the Darwin of the new movement, as Harrington Emerson is the Huxley —the popularizer and propagandist. Taylor began his experiments about 1880, in the shops of the Midvale Steel Company. In the course of his investigations, Taylor used up very nearly four hundred tons of steel in a period of twenty-six years. But at the end of the period, he had discovered the efficiency of high-speed steel. He had invented "motion study"—an exact timing with a stop-watch of the various motions that are made in performance of a routine task. He had created the "Job-card"—a card given daily to workmen, describing in exact detail how certain work is to be done. Also, and by no means least, he had revolutionized the ordinary wage-system, by instituting a graduated method of payment that rewarded every worker according to his output.

The "Taylor System" as it is often called, was first introduced into iron and steel works. Mr. Emerson introduced it into shops of the Santa Fé Railroad in 1903, effecting a saving of £300,000 a year. Soon it began to spread to mills and factories, until to-day there are fully half a million workers in the United States who are receiving its benefits. It has been adopted by the United States Government in several of its work-shops and departments; and as a whole it is now accepted as the ideal method of manufacturing.

Although Taylor and Emerson both confess that they were followers of Darwin, it is still a fact that "Scientific Management" is a wholly American movement. Its experiments were American. Its leaders were American. Its literature,

now comprising fully one hundred volumes, is entirely American. In short, with regard to the whole matter, we are still more than ten years behind the United States.

By way of illustration of the foregoing article on Scientific Management, we reprint, with the kind permission of the publishers of the magazine *System*, The A. W. Shaw Company, Ltd., the following article which appeared in their issue of May, 1916:—

NEW METHODS THAT HAVE INCREASED OUTPUT

By Cecil Chisholm

In April *System* a writer stated his conviction that, if output could be increased by 30 per cent. in this country, the burden of war taxation could be lifted from industry within a few years, and pre-war prices reduced to the consumer.

The question which remains is: Is it possible? The writer had pointed specially to the methods known as "Scientific Management" as the best means for effecting such an increase in output. But so far it had been difficult to discover a single factory in this country which could be described specifically as under "Scientific Management."

However, this difficulty has been overcome. The privilege was recently given me of seeing over a factory near Manchester, now controlled by the Government, which is run largely on the principles laid down by "Scientific Management." For obvious reasons it is impossible to specify the location of the factory and the particular work on which it is now engaged.

About five years ago the management found out that by making "time studies" they could greatly improve output in certain sections of their work. They discovered, too, that "Scientific Management" is not a standard pattern which can be imposed on any factory. As the manager said, "It is impossible to take a system and make the factory fit that system. The system must be adapted to fit the factory. . . . The point I want to make is that we found ourselves able to double output without putting any additional strain whatever on our operators, and without asking them to work for a single additional hour. I believe that increase of output must come from speeding up the plant rather than from speeding up the men.

"Let me give you some specific instances of our experience. Four years ago we were making one cycle chain roller in ten seconds. Now by studying the whole processes involved we are able to eliminate a number of unnecessary movements both on the part of the man and of the machine. The result is that we are now able to produce three cycle chain rollers in eleven seconds.

"Now this does not mean that we were able to treble our output with no additional expense. The wear on the machines working at this increased speed of output is more heavy.

"Briefly, it may be said that the problem in getting an increase in output involves two difficulties:—

"1. Getting the conditions suitable for increased output.

"2. Getting the increased output out of these conditions.

"This is what we discovered when we had been securing the increased production of cycle chain rollers for about a fortnight. For some reason or another we could not keep up the increase with any certainty."

HOW TO MINIMIZE STOPPAGE OF MACHINES

"The chief difficulty we found to be the continual stoppage of the machines. Now why do machines stop? In the majority of instances they stop for the changing of tools. Obviously we must make it easier for the man to do this.

"Accordingly we decided to make all our tools absolutely standard size, as well as the tool-holders. For this purpose we organized a store organization, which included the keeping of sharp new tools in the room for every job on the floor. At the same time an electric bell was installed at the operator's hand on every machine. Instead of fiddling about when he wants a tool sharpened, the operator now merely presses a button and the boy comes immediately for the tool and has it ground.

"We found that in our whole factory this was the chief cause of the loss of time and work. By this new arrangement we have been able to save 60 per cent. of the time lost in changing tools. At the same time parts wear out with increased rapidity when machines have been speeded up. So much is this the case that we not only have standard parts ready, but actually rebuild many of our machines, in addition to patching them up. In this particular department we reckon on rebuilding one machine per fortnight.

"This is the biggest single step towards increasing production that we have yet made. The next difficulty is to secure the continued increase, not only on day to day production, but on month to month production. To do this we found it essential to institute a central planning department.

"We discovered, like most other people, that each separate department was an enclosed mystery. The key was locked in the head of the foreman. Now we decided that this must stop. The planning department must have its hand on every job that was being done in the shops. I may say that we lost the superintendent of the department over that. Foremen had been accustomed to giving instructions as to what was to be manufactured. Now we insist that it does not matter to the superintendent what is being made on the floor, so long as the work satisfies the inspector and the machines do not stop. The head planning office settles what programme of production is wanted, and settles it along the lines of the selling programme. We found that to have the work routed by the planning department, recorded by the work-in-progress department, and checked by inspectors in each department, gives us an over-all efficiency. The foreman and his men are required to think of nothing except getting specific jobs through.

"With the help of this system and the use of standard piece times obtained from time studies, we were able to get some remarkable increases. The output of one piece of equipment has been increased by no less than one hundred and fifty per cent. For obvious reasons I cannot specify that article.

"But I may say that in making chain links we obtained an increase of from seventy-five to one hundred per cent. by carefully studying every motion involved. First of all we studied what was the most economical weight for the girl to handle without unnecessary fatigue. Then we discovered that we could lighten the weight of the links by making the tubes for the holders of aluminium.

"Finally we studied the output of the girls hour by hour. As a result we found a very heavy falling off during the latter part of the morning. Accordingly, we instituted a break of a quarter of an hour, during which we provided the girls with a glass of milk. The result was remarkably successful."

GIVING THE GIRL WORKER A 150 PER CENT. BONUS

"I may say that most of the girls at our works are in a

position to earn bonuses. We set the time which could be attained by a good worker doing her best, and we give a relatively high reward to every girl who attains sixty per cent. of this efficiency. She is entitled to sixty per cent. on the top of her day wage. This represents fifty per cent. of the wages saved to us. When she reaches one hundred per cent. the bonus rises up to sixty-six and two-thirds of the wages saved to us.

"It is sometimes said that one should reckon a bonus on profits, but who shall say what precise profit, if any, is earned by an individual machine? In reckoning our machine rates we allow for depreciation, for power costs, for the expenses of design (in the drawing office), and for maintenance. But whatever one does, costing for a machine must always be largely guesswork.

"I notice that Lord Rothschild thinks that labour will be fatally antagonistic to any scheme for increasing production. I want to say most emphatically that, so far as I have had any experience, labour is not antagonistic. But, of course, labour must be approached both with courtesy and with tact.

"Before we made a single change at our works we had a series of conferences with the men and with the leaders of the Union. We found them both most interested, although perhaps a little suspicious at first, but I would like to say that neither were in any way obstructive or apathetic. We have never found any desire on the part of the Union people to limit production at all. The officers all recognize that more has got to be done, and I think that they will agree that this is still necessary after the war, if labour realizes that it is going to get some—not necessarily all—of the increased profits.

"I should say here that I think that a great deal of discontent is caused by the tyranny of the small overseer. We do not allow our foremen to dismiss men. They can only recommend the men for dismissal to the employment department. I think it is essential that the men should have some way of getting at the directors personally with any grievance. Then they feel that they are not sentenced unheard. Unfortunately the man who has risen from the ranks is apt to think that there is only one way of dealing with men, and that one way is not always tactful.

"If these things are watched, I see no reason why labour should not co-operate with capital to secure an increase of

production far higher than thirty per cent. My own conviction is that at bottom the British working man is more easy to deal with than a worker of any other country, through his sporting instincts.

"So far as our industry is concerned I think that a general increase of thirty per cent. would be easily obtained. There are great factories known to me where lost time is simply lying about waiting to be picked up. I do not think that actual time studies are the most helpful part of 'Scientific Management,' but I think that the formation of a planning department is essential in every large business.

"It is absolutely impossible to discover where the losses have been taking place unless you have before you an actual comparative record of times, quantities, and prices. Too often the general manager has no statistics available to tell him what his works are actually doing. This planning department is, to my mind a vital feature of 'Scientific Management,' and should be very carefully considered by English employers.'

§ 2 Standardization

STANDARDIZATION is a word which has come into prominence in connection with manufacturing, but which is now being used in connection with all manner of industrial and commercial activities.

In the early days of hand-labour, there was practically no standardization in production. The skilled workmen of the guilds produced no two articles alike. Not until the age of steam dawned in Great Britain did it become possible to have factories instead of hand-labour. Once factory production became established, inevitably there came improvements and more accurate methods, all moving in the direction of standardization and greater efficiency.

Thus, standardization was born in Great Britain. It was made possible by steam-power and machinery. But in the past twenty-five years it has been developed to a vastly larger growth in the United States. Practically all the literature of standardization comes to us from America.

Standardization means that it is better and cheaper to produce a million articles all alike than to produce a million articles all different. It means that there is one best or most

convenient way to produce a thing. There is one best shape. There is one best weight. There is one best material. There is one best motion, and so forth. When a single article is produced in vast quantities the work of producing it becomes automatic. It requires less skill and less thought; and it can be produced at greater speed. In the production of a vast output nothing has been more magical than standardization.

The one best illustration is that of the Ford motor works. Here the cars are manufactured more alike than blades of grass. They are identical. Every worker is thus enabled to do the same thing over and over again. There is the utmost speed and accuracy; and as a result more than a thousand finished cars are turned out in the course of a single day.

In Great Britain the development of standardization was prevented by a number of influences. It was prevented by artistic and socialistic influences—by the writings of William Morris, Ruskin, and Carlyle—by a general tendency to favour products of hand-labour, and by a large degree of hostility among wage-workers.

Standardization is opposed to traditionalism. It weeds out methods that have grown up in a haphazard way. It encourages managers to study and analyse the operations of employees, and to select and standardize those ways and materials which are best suited to produce the highest percentage of result.

Owing to the importance of this subject we are adding to the above concise statement one which goes into greater detail. The following article will show to what a great extent the early adoption of standardization has contributed to the manufacturing supremacy of the United States:—

Standardization is the science of making the utmost use of the unit. In productive engineering there are, as the old adage has it, "more ways of killing a cat than choking it with butter," and it is found that by concentration of thought and effort upon one thing it is possible to devise means of producing it, and to effect modification in its design, which render production vastly simpler and enormously cheaper than was possible by the means by which it was first made; and it is further found that the quantity in which goods can

be produced is a very important factor in determining the methods which can be economically employed. Hence, production on a large scale will be conducted very differently to production on a small scale, and it follows that the first consideration in deciding upon or devising methods to be employed is the size of the market—in other words, the quantity possible to be sold.

The production, for instance, of a newspaper printing machine cannot be carried out on the same scale as the production of a typewriter, although both may be standardized. In quantity production, it is possible to employ tools of a nature which it would not be economical for the small producer to use. As an example, an American motor factory employs a machine which does in less than one minute work which, by the ordinary means employed, would occupy an hour or more. That machine, however, cost £1,500, and it is able to complete its work 1,000 times a day. To employ such a machine where the output is but two or three thousand per annum would be absurd. It would do a year's work in three days. Faced with the problem of exceptionally high wages, the American producer has been forced to concentrate his attention upon methods by which machines replace skilled labour, and favoured by a very large and receptive home market, has done so with such effect that, where quantity permits, he is able to produce many articles at such low cost that European manufacturers, in spite of lower wages and cheaper material, cannot compete. This is particularly the case in small articles, such as typewriters and sewing-machines, which can be produced by the 100,000, and the small parts of which lend themselves particularly to the use of automatic reproductive machinery. In typewriters, which originated in America, that country practically supplies the world. Germany is a competitor in sewing machines and in "coin-in-the-slot" machines, in which quality is not so important. Our enemies enjoyed before the war almost a monopoly, being assisted by their cheap labour; for, of course, if the same productive methods are employed on the same scale, cheaper labour must score, even where only one partly skilled man "minds" half a dozen or more automatic machines. Cash registers are another monopoly of the United States, coming for productive purposes in the same category as sewing machines and slot meters. America, of course, does not monopolize all the

fields of standardized quantity production. In this country three-speed hubs for bicycles are produced at the rate of 250,000 annually, and they are made nowhere else except in Switzerland, which latter country has standardized watch movements and supplies the bulk of those used in Europe. In complete standardized watches, too, Switzerland does a large trade, but the largest factories producing these are in America, where they are turned out by the million at a cost of from about half-a-crown upwards. Here we have standardization in the highest degree, and watches were amongst the first articles so treated, owing to the huge field open for their sale and to their small size, and hence the small cost of transportation to all parts of the world. Cyclometers are also turned out by the million, much of the small mechanism being produced by die-casting, no cutting tools being required at all, even for gear wheels, while of course, such things as nuts, bolts, and screws form a ready subject for standardization and are so produced in all parts of the world, this country having been the pioneer in this branch of industry, particularly in regard to wood screws. Bicycles and bicycle fittings are another British standardized line, in which America, which set the pace, has had to take a back seat. The standardization of sizes of articles used by a special trade has led to enormous production at little more than the cost of the material. Thus, gas fittings are standardized, both as to pipe sizes and screw threads, so that reproductive methods can be safely employed. Germany has had a large share of this trade, whilst America has carried the system further, and by standardizing sizes in pipe fittings generally has been enabled to produce in such quantities as practically to control the market. But it is when we come to consider large articles that American producers have set the world so big a lead, favoured, as aforesaid, by the large home market and receptive public. "Why should I pay a dollar when I can get it for 50 cents?" is the motto of life with the American people, and so American producers aim at cheapening production costs everywhere, with the result that hundreds of firms there embark large capital upon the production of single standardized details of other machinery. Thus, in the automobile industry, large plants are employed solely on the production of such things as sparking plugs, valves, rims, gear wheels, universal joints, and in such complete units as engines, clutches, gearboxes, axles, and steering

gears, so that American cars are largely produced by the combination of a series of assembled parts, which manufacturers can buy more cheaply than they could make them in their own factories. In the case of those firms producing cars in their entirety in their own shops, concentrating on single models, the most wonderful system prevails, the climax being perhaps reached by the travelling platform assembly, under which the chassis automatically passes on, during a period of some 3½ hours, coming in turn under the attention of successive series of men, who do nothing else but put on and screw up (say) a wheel. In this way a single factory can turn out over 1,500 complete cars a day! In agricultural implements, simplification and standardized production have resulted in machines being sold at prices so low that it pays the farmer better to leave them in the open and to buy new ones when they fall to pieces. As a Canadian farmer said when criticized for the apparent folly of leaving expensive machines unprotected, "Well, mister, that machine only cost $75. I suppose your people would spend $100 for a barn to put it in? *We* find it pays better to leave it unprotected and when it falls to pieces buy a new one, with *all the later improvements in it.*" It may be mentioned that one manufacturer is now organizing a plant to produce light agricultural tractors at the rate of 500,000 per annum, although none have yet been sold, but a retail price of approximately £40 is confidently expected. Buggies are another large standardized article, and are retailed by some factories for as low as $25 complete—four wheels, under-carriage, shafts, body and all—and a new set of wheels is sold for $6.25! In roll top desks and office furniture, reproductive methods in wood-working have given America very nearly a monopoly. Another line to which standardization is being applied with similar results is pianos, one method in the construction of which may be mentioned. Metal frames being employed and the entire number of holes—some 280 entering the frame in all directions—being drilled by one machine at one operation, the frames coming automatically under its operation and being as automatically removed when completed.

It will thus be seen that, where the market exists for any article, the manufacturer who has the pluck first to standardize and produce in quantities will find that the price at which he is thereby enabled to sell will get rid of his goods quickly and secure him the market.

Standardization of	typewriter	America.
,,	sewing machines	,,
,,	speed hubs	Gt. Britain and Switzerland.
,,	watch movements	Switzerland.
,,	watches	Switzerland and America.
,,	cyclometers	America.
,,	pianos	,,
,,	gear wheels	,,
,,	nuts	,,
,,	metal frames for pianos ..	,,
,,	bolts	,,
,,	buggies	,,
,,	screws	,,
,,	roll-top desks	,,
,,	wood screws	Gt. Britain.
,,	bicycles	,,
,,	bicycle fittings	,,
,,	pipe fittings	America.
,,	gas ,, ...	Germany.
,,	motor-cars	America.
,,	sparking plugs	,,
,,	valves	,,
,,	rims	,,
,,	general office furniture ..	,,
,,	universal joints	,,
,,	engines	,,
,,	clutches	,,
,,	gearboxes	,,
,,	axles	,,
,,	steering gears	,,
,,	agricultural implements ..	,,

§ 3 Advertising

By Charles Frederick Higham

Advertising is the scientific method whereby facts of importance are made known to the largest number of people at the least possible expenditure of money or energy.

Its appeal, to be effective, must be psychologically sound—that is to say, the printed advertisement must be pleasing to the eye and impressive to the reason. It must establish a

favourable attitude to the thing advertised, and create a desire for its possession.

With the vast development of industry during the last fifty years Production outstepped Distribution in Efficiency.

Advertising, *by creating markets,* righted the defect. It initiated a method whereby the merits of every commodity might become instantly known to the world at large.

Business men all over the world have to thank America for this brilliant development of the art of selling. America is a young country yet, and she has the daring, the exuberance of feeling, the belief in herself, of youth. We owe to this nation the creation of a new method for the world-wide distribution of Intelligence—Commercial Intelligence. They have tackled the advertising problem with courage; they have abolished space brokerage. The trained American advertising man is not out to save money but to make money—for his clients.

The most enlightened English business men have followed this lead, and every year advertising in this country shows truthfulness, and more originality, confidence, and technique. Those with the greatest faith and daring have had the greatest success.

Advertising, like other arts, reaches excellence through that quality called technique. The medium of press and hoarding publicity being Language, Type, Design, its technique is naturally that of Writing, Draughtsmanship, and Lettering. But the ingenuity of its expression—the dynamic of its effect—is entirely its own. Herein lies its true creative element.

The Science of Advertisement was invented for commercial purposes; there is no more potent selling force to-day. But already we see it being used with administrative design. Witness the War Publicity Campaign. The British Government, faced with the problem of having to reach *with the utmost dispatch and effect* the intelligence of the nation at large, adopted the method which had been initiated, developed and perfected by American business men. Recruits were raised, and War Loans taken up, hospitals equipped, ambulances built, war depots created, charitable funds augmented by organized publicity—the only prompt and effective means to this end. The moment one needs collective help, the moment one has reason to appeal to the collective mind to-day, one *must* advertise. It is now the only sound method.

In future the reformer, the philosopher, the publicist, the

politician, will fall into line with all good business men. For what is the dominating passion of such people? The wish to approach lucidly, effectively, *at once*, the mind of every person; to present to them a digest of their arguments, so simply put that even the unthinking can understand, and understanding, respond. That is the ultimate function of advertisement; it is now in practice in America, and should be in practice here.

§ 4 Correspondence Schools

By Edgcumbe Brighten

Although the idea of carrying on education through the post originated in England, it was left to the United States of America to develop it and bring it to the notice of the general public.

I think I am right in saying that the first correspondence school was founded in Cambridge, and still exists. This school specializes on classics and coaching work for University degrees.

The International Correspondence Schools, which form by far the largest educational institution in the world, were founded just twenty-five years ago in Scranton, Pennsylvania.

It is interesting to know that the idea of founding the International Correspondence Schools was conceived really through an accident. The Founder, Mr. T. J. Foster, was the editor and proprietor of a small daily newspaper, which had its circulation in the coalfields of Pennsylvania. In one of the accidents which frequently occurred in the mines, owing to lack of knowledge of the laws of mine ventilation and the chemistry of gases, he lost one of his best friends. Mr. Foster then commenced giving instruction in Mining Engineering in his newspaper, and this met with such success that he decided to issue a course of instruction which he could publish separately from the paper.

The problem of conveying the knowledge over so large an area was a difficult one, but Mr. Foster seized on the idea of correspondence tuition, which was already in use in a primitive way in this country. He thereupon imported and re-wrote into short lessons the then existing English mining text-books, and adapted the whole to a thoroughly practical and

systematic course of study that fully met the requirements of the American miner of limited education. Besides importing textbooks, Mr. Foster secured the services of a number of English mining instructors, so that the real development of the great correspondence schools was due to the initiative of Mr. Foster, whose ancestors came from Ipswich, and to English textbooks and instructors.

The success which followed the founding of the International Correspondence Schools was so immediate that other courses of instruction were prepared. To attain the greatest success, only the very best and most practical writers were secured to prepare the textbooks. Since the formation of the Schools in America, nearly two million people have enrolled as students.

It was nearly seventeen years after Mr. Foster inaugurated his system in America before the benefits of this eminently practical form of technical instruction were really appreciated in this country. It was then decided to found an English institution on the same lines as that in America. This was done, and the success which rewarded the efforts of its promoters quickly proved that a long-felt want had been filled, and so, while the idea of teaching by correspondence was born in this country, it needed the energy and initiative of our American cousins to bring the system into really popular and practical use.

In the eight years that the Schools have been in existence in England they have enrolled in this country and in other parts of the Empire considerably over a quarter of a million students. The efficiency and practicability of this method of tuition are appreciated when one realizes that from that small beginning in Pennsylvania, great schools have been built up in this country, in Spain, France, and South America, by using the system invented by Mr. Foster, but with courses of instruction prepared in the respective countries.

THE PRESS

The Dynamic Power of the Press

WITH the tiny news sheet, first published in 1625, the foundation of the mighty modern Press was laid. The earliest recognition of the vast possibilities of influence over the public

which the Press possessed we owe to America. American journalists were the first to realize that a medium so widely read might be employed to mould and direct public opinion—that the newspaper could be made much more than a disseminator of news. In the columns of the American Press ideas first became fluid, and plans for great reforms were laid.

One by one English journalists have come to perceive and to use this power. Lord Northcliffe was the first to realize it to the full. Until his personality was felt in British journalism, newspapers consisted mainly of news—not views. To-day, views are more interesting than news, and pictures, to a large extent, supersede description.

No other force in the world has the same potency as the Press for good or evil—no other medium has its far-reaching influence or catholic appeal. It is the melting-pot of Thought. It exists for the circulation of intelligence—it acts as an "exhaust" for our seething beliefs.

So perfect is its organization, so infinitely persuasive is its method of appeal, that it can pipe almost any tune upon that impressionable disc—man's mind.

Herein lies its danger, and its tremendous potency as well.

The Press is a wonderful exemplifier of the two great camps into which humanity can be divided. In politics we call them Conservative and Liberal. The tendency of the first is to *conserve,* to preserve the old traditions; it is passive. That of the second is to *progress,* make changes, break with the past; it is active. So the pendulum swings; there is neither too much change, nor yet too much stagnation.

The Press ably represents both points of view, both types of mind; keeps the pendulum swinging; crystallizes the creed of both extremes.

The power of the Press is due to:—

(1) Its great wealth, gained chiefly by the enormous revenue it draws from Business Houses in exchange for the publicity it can give to their affairs.

(2) Its amazing organization, whereby news from every corner of the globe is gathered in, sifted, written up, printed, and distributed with the most extraordinary speed.

(3) Its complement of readers—every Tom, Dick, and Harry in the British Isles, and to a great extent, those in the colonies, and all Englishmen abroad.

(4) The fact that it is the accredited spokesman of the National Mind.

The Press can make and break reputations, strengthen loyalty, create enthusiasm for great causes, turn the fate of Governments, collect sums of money of almost any size.

In so far as it is free it is virile; and in so far as it keeps in sympathy with public feeling it is wise. Its power is dynamic because its methods of expression are all highly skilled, and because it performs a vital function both in the realm of thought and in the conduct of affairs.

THE OFFICE

§ 1 Modern Office Buildings

THE finest modern office buildings in the world are seen in the big American cities. So impressive are they that they form the chief architectural feature of New York, Chicago, and Philadelphia. All strangers are struck by the remarkable significance of their design. Even poets, the late Rupert Brooke for example, have been inspired by their peculiar distinction of form.

The dominating passion of the Americans is business. They view it with an idealism that few Englishmen understand; and outward expression is given to the fervency of their ideas by the manner in which they house themselves during working hours.

A New York "Woolworth" leaves two distinct impressions on one's mind. One is that the Americans' conception of business is extremely dignified; the other that they are a people who love to eliminate waste.

Dignity and efficiency—we will view these qualities in turn.

Any old building serves the purpose of the average English business man. But the American is unhappy unless his offices are well designed and well constructed, spacious, airy, light, and in short *noble*. Big corporations in most large capitals have proud premises, but in America even a moderate sized

firm houses itself in an up-to-date style. The streets, far from being disfigured, are enhanced by their office buildings when they are modern or modernized.

An American's sense of efficiency is extremely acute. He wastes no land; that is why his office buildings "scrape the sky." He wastes no time; that is proved by the swift-moving lifts, and the perfection of his telephonic system of communication. He wastes no energy, because downstairs there is a boot-black to clean his shoes, a barber to shave him, a manicurist to trim his nails, a shop to sell him cigars and cigarettes, and papers to give him the latest news.

Efficiency is shown in the steel frame construction of the building, the elaborate anti-fire contrivances, the centralized system for giving heat. And the same scientific feeling governs the equipment of the rooms. The American has learnt of the effectiveness of steel as a medium for all sorts of things pertaining to the business world. He uses steel furniture, steel depositories, steel cabinets for precious records, defying every element of danger. There is no invention for saving time or trouble that he does not welcome. The Cash Register, the Typewriter, the Dictaphone, the Adding Machine, the Bell Telephone, the Letter Opener, etc., are now all ancient American history and the big banks have systems of silent intercommunication, which to the uninitiated are as though a thousand genii were at work.

The chief's room is heavily carpeted, with sound-proof, fire-proof doors, and in a complex organization, with a complete system of communication with all the important branch offices. A few choice ornaments grace the room, and there is none of that dingy, musty atmosphere so common in English offices pledged to the "idea" behind the *cliché* "Business is Business." (So a tin pail acts as coal scuttle, and if the poker has no handle, it does not matter in the least!)

In fact, Business in America is a dignified affair of absorbing interest and infinite significance. Science therefore becomes the god that evokes efficiency, from the steel skeleton framework of the office walls to the safety fountain pen with which the clerk records official memoranda on index cards that challenge inaccuracy and forgetfulness.

The American dares to nourish with money the place where money is bred.

§ 2 The Telephone

THE invention and development of the Telephone form a striking instance of the general truth that most modern inventions have been produced by men of British blood *residing in the United States.*

In the forty-year history of the telephone, only two important improvements have been made by British inventors living in Great Britain. Only three have been made by men of non-British stock, and all the others by men of British birth or lineage living in the United States.

The original inventor of the telephone—Alex. Graham Bell—was born in Edinburgh in 1847. He went to Canada in 1870 because of a tendency to tuberculosis. A year later he went to Boston; and in 1875 he invented the first practical telephone apparatus. His American patent (No. 174,465) was the most valuable single patent ever issued, as there is to-day over £400,000,000 capital invested in telephony in the civilized countries of the world.

Bell's telephone was first shown at the Philadelphia Centennial in 1876. Here it was seen and appreciated by Lord Kelvin who brought the first pair of telephones to England. The first telephone company consisted of four men—Bell, Hubbard, Sanders, and Watson—all men of British stock. The first business manager of the telephone, who was really the creator of telephone organization, was Theodore N. Vail, whose forefathers emigrated to New Jersey from England in Pre-Revolutionary days; Bell's invention was only the bare beginning of telephony; it was no more than the receiver. All else, the switchboard, the wires, the cables, and so forth, had to be invented later by others.

The transmitter was invented by Edison, Emile Berliner, Francis Blake, White, and the Rev. Henry Hunnings, an English clergyman, who suggested the use of small granules of carbon.

The switchboard has been perfected mainly by Charles E. Scribner, an American. It was first invented by E. T. Gilliland, but the greatest part of the development was the work of Mr. Scribner, of Chicago.

Hard-drawn copper wire, which is most suitable for telephone transmission, was invented by Thomas B. Doolittle, a Connecticut Yankee.

Underground cables, after many failures, were perfected by John A. Barrett, who first introduced paper wrapping, and by F. A. Pickernell, who laid the first dry core cable. The "Phantom Circuit" was invented simultaneously by Jacobs in England and Carty in America. This marvellous invention enables three messages to be sent simultaneously upon two pairs of wires.

The "Pupin Coil," which has made long distance telephony possible, was invented by Professor M. J. Pupin.

The Bridging Bell, which puts four houses on a single wire, was invented by J. J. Carty.

Telephone engineering as a whole has been developed most by J. J. Carty, of New York, who was born in the South of Ireland.

The Western Electric Works in Chicago, which has made three-fifths of the telephone apparatus of the world, was built up by Enos M. Barton and H. B. Thayer.

Telephone service has been developed to its highest point in Europe by Henry Cedergren in Stockholm, and to its highest point in the world by Union N. Bethell in New York.

Thus we see that men of British names have created Telephony. There is one German Jew—Berliner; there is one Hungarian—Pupin; there are two Englishmen—Jacobs and Hunnings; and there is one Swede—Cedergren. All the others are of British birth or lineage.

Bell himself came to Great Britain in 1878. He lectured in many cities and tried to obtain capital and contracts. He got neither, and returned deeply discouraged to the United States.

The first London exchange was not started until 1879. It was a tiny affair of only ten wires.

London to-day has one-third as many telephones as New York City. It has not as many telephones as the City of Chicago. The one American State of Ohio has as many telephones as Great Britain, and a much higher quality of telephone service. Roughly speaking, Great Britain has a twenty-five per cent. telephone system compared with that of the United States, and the Mecca of telephone engineers is New York.

Europe in proportion to population has only one-thirteenth as many telephones as America. The United States has eight telephones per hundred of population. Canada has four per

hundred, and Sweden has three. Great Britain has less than two per hundred.

There is no reason to believe that American superiority will be less in the future than it is to-day. There are at present over three hundred telephone experts in the employ of the Bell Telephone Companies of America, who are still inventing and improving. We have no such body of experts; and more than this, there is not a single department in the telephone business which has been developed to its highest point in this country. In all matters of telephony we have been left behind by Sweden, Canada, Germany, and the United States.

The recently completed trunk line between Boston and San Francisco, 3,500 miles in length, over which conversations are now being successfully held, is one of the electrical marvels of the world.

Transmitter	America.	
Switchboard	„	
Hard-drawn copper wire ..	„	
Underground cables	„	
Phantom circuit	„	and Gt. Britain
Pupin coil	„	
Bridging bell	„	
Telephone engineering	„	

§ 3 Office Systems

THE American mind is always quick to appreciate any process which will save time and trouble, and in nothing is this more apparent than in the development of the modern office. It is no exaggeration to say that American methods have revolutionized office working, and by the excellence of the ideas they have adopted they have compelled the whole civilized world to follow their example.

A generation ago the head of a business would spend some hours of his day in writing business letters personally. Now he dictates them in a short time to a stenographer who brings back typewritten letters for his signature. A duplicate will also be available for filing and for future reference. If he is quite up-to-date he will speak his letters into a dictaphone. The typist takes the record, places it on her machine, and types the letters as they are dictated to her, no time being wasted by making preliminary shorthand copies. Shorthand

was invented by an Englishman, but it was America which realized the value of the invention for business purposes and showed the world how it could be applied. America supplied the typewriter, which gives an easily-read letter and several duplicates if they are required. America gave to the world the scientific filing system, which enables any duplicate to be found at once. She gave also the calculating machine, the billing and adding machine, loose-leaf ledgers, card ledgers, and many other useful devices and machines, all of which have been adopted by other countries, and which tend to reduce error and inaccuracy, which create order where chaos used to reign, and make it possible for managers and heads of departments to devote their time to their proper functions of directing the business, instead of wasting part of it in writing letters, and hunting for records of past transactions which have been mislaid.

One of the most widely adopted of these machines is the cash register. This has been adopted still more widely in shops and stores than in the office, and has been of immense value, not only in saving time by recording sales and transactions and keeping the accounts, but also in doing away with the old-fashioned open till. The till is always liable to mistakes which cannot be traced, thereby placing temptation in the way of assistants. This is a state of affairs which is bad for everyone, and therefore ought not to be tolerated.

By these and other methods America has revolutionized modern office and business life, has made the lot of assistants and clerks more pleasant, has saved an immense amount of worry and muddle, and by increased efficiency has brought increased prosperity to all those who have followed her lead.

A LIST OF DEVELOPMENTS IN OFFICE EQUIPMENT AND ROUTINE

STENOGRAPHY.—Invented in England, but its application to business for dictating letters, etc., originated in America, and was developed far more rapidly in that country than elsewhere.

TYPEWRITER.—This was invented and developed in America, and nearly every improvement, such as visible writing, has originated there.

DICTAPHONE.—An American invention, and entirely developed there. It enables the employer to dictate his letters

when he likes; they are afterwards dictated by the machine to the typist, no time being wasted by stenography.

CARD INDEX SYSTEM.—This was invented in America, originally for cataloguing libraries. It was then applied to business with complete success and has revolutionized office methods.

VERTICAL FILE.—A development from the Card Index System, for cataloguing letters, etc. Entirely American.

CARD LEDGER.—An American invention and developed there. Saves keeping a multiplicity of cumbersome ledgers, and enables any heading to be increased indefinitely.

LOOSE-LEAF LEDGER.—Invented and developed in America. Allows accounts to be typed, old ones can be removed, current ones increased to any extent.

INVOICING AND ADDING MACHINE.—Invented in America and developed there to a remarkable state of reliability and efficiency.

ROTARY DUPLICATOR.—Invented in America; developed there and in this country.

ADDRESSOGRAPH.—The first practical machine was the invention of an American in 1892, and was sold very largely in the United States. As the demand grew, an English branch was established, and whilst minor improvements were made here, the most important developments have been American. The output of these machines is approximately ten American to one English.

The Addressograph is a mechanical device for addressing envelopes, circulars, etc. The stock addresses are made by means of the graphotype on metal plates, and then inserted in any order prearranged in the addressograph, which automatically prints the addresses through a ribbon—a facsimile of typewriting—at a very high rate of speed. This invention has revolutionized the old method of addressing envelopes by hand.

The main varieties are:—

Addressograph, hand	America.
,, motor	,,
Graphotype, hand	,,
,, motor	,,

ROLL TOP DESK.—Whilst the trade in these has been mainly American, the roll top desk is not exactly an American invention, but an adaptation of the old-fashioned

English cylinder desk. The cylinder desk is more or less a roll top desk, and was made in England many years before America copied and adapted it. The difference between these two desks is that the cylinder desk had one solid roll, whereas the roll top desk as manufactured in America was made with a shutter on the same principle as is used for shop-fronts. By far the larger proportion of these desks are made in America. This fact is due to the natural resources of that country, *i.e.*, timber—cheap and unlimited; also better equipped works. During the last twenty years nearly all the desks used in this country have been supplied by America in separate pieces, these pieces being cut, sawn, shaped, and rough-planed in America, then sent to England to be assembled, smoothed and polished.

Roll top desk .. .. America.

SECTIONAL BOOKCASES.—The sectional idea was conceived by Mr. Wernicke, an American-born citizen, in connection with the storage of spare parts for the Harvester Co.'s harvesting machines. About twenty-five years ago the system was applied to bookcases. This "unit" idea has now become practically universal throughout the whole of the filing cabinet industries. The original bookcases were simply so many empty boxes placed one on top of the other. Later on, end irons were introduced to interlock and so render firm the whole range of cases. The next development was the attachment of the swinging glass fronts, and still later patent equalizers which enable the glass fronts to slide easily in and out without jamming. The advantage of the glass door, which is fitted with felt slips, is that it is absolutely dust-proof, and as the door slides over the top of the contents of the unit, everything inside is instantly accessible.

The manufacturing of sectional bookcases is still almost exclusively carried on in America, where large modern factories have been established.

Sectional bookcases .. .. America.

§ 4 Decimal Coinage and the Metric System

THE Metric System is a good example of one contention of this book, *i.e.*, that other nations have more quickly appreciated the value of new ideas and assimilated them than has

Great Britain. The following is a short description of this most important and desirable aid to efficiency.

No man on earth who makes anything, sells anything, or keeps accounts concerning anything that is imported into, or exported out of, Great Britain but must admit that it would not only be a great convenience, but a source of great economy if this country and every other country she trades with (*i.e.*, all the world) had one common system of Weights and Measures and Coinage, so that one sign meant the same size to every workman in the world, and one figure the same value to every book-keeper.

No longer then should we be faced with the necessity for using conversion tables in order to find out the relations between (say) kilos and the equivalents in British weights, or rendering florins and dollars into pounds, or finding out exactly how many miles twenty-five kilometers are. One figure would express the same thing to everybody, and we should have arrived at an International language, at least as far as Weights, Measures, and Values are concerned.

This is, of course, a picture of things as they should be, not as they are, yet there is nevertheless a growing feeling in favour of doing something to bring about an adoption of one system by the leading manufacturing countries of the world in order to facilitate still further that exchange of commodities which we call Trade. For the British people the question is: Which is the best system, ours—or should we do better by adopting that of our great neighbours, who are at once customers of ours just as we are customers of theirs, who are our rivals in the various markets of the world, and who almost all of them use what are known as the metric and decimal systems?

In making comparisons between the two systems (British and Metric) the first thing to note is that the British systems of Weights and Measures and Coinage are peculiar to ourselves. Apart from their merits or demerits, as systems they stand alone. Outside the British Empire (and they are by no means in use all over that) only the U.S.A. use British weights and measures, and they have a decimal system of coinage. Moreover, there is no possibility of any other nation being persuaded to use them, and it becomes daily more apparent that if we persist in retaining them we shall eventually be left to use them alone.

On the other hand, the metric system, which dates only from the period of the French Revolution, has been adopted not only by France, Germany, Holland, Belgium, Austria, Italy, Spain, and Roumania in Europe, as well as by all the South American Republics, but even China has instituted a system of weights and measures that is based entirely on the metric system. In the United States also a bill has been introduced into the House of Representatives which would make the metric weights and measures the only system in use in 1920.

Evidently then the metric system is going ahead, and already claims as adherents most of the great commercial nations, whilst on the contrary the British system not only has never been adopted by any other nation, but a large and ever-growing section of British business men are urging upon the legislature the necessity of substituting the metric system for our own. In Australia, the Commonwealth House of Representatives passed a resolution with only two dissentients urging the Government to seek the approval of the next Imperial Conference for a reform of the British systems in favour of the metric and decimal systems throughout the Empire, and failing that, "that the Commonwealth should proceed to the consideration of such a reform in Australia and invite the co-operation of the Dominion of New Zealand therein." At the Pan-American Congress held in January, 1916, resolutions were passed in favour of the adoption by the U.S.A. of the metric system, in order to bring the States in the Union into closer touch with the rest of the nations inhabiting the American continent. Therefore it follows that as a universal system of weights, measures, and coinage would be of advantage to commerce, we as the commercial nation of the world must substitute for our own that system which is evidently well on the road to be universal.

That we must do that is clear, even if there were any doubt (which of course there is not) of the metric and decimal systems being better than our own. So much in the interest of logical ideals. But where logic appeals to the few, interest appeals to the many; and that our interests have suffered incalculable damage by our persisting in sticking to our insular system of weights and measures no man who has studied modern business conditions can have any doubt.

The damage begins as soon as the young Briton goes to school, where he finds himself condemned to spend long hours learning our truly ridiculous tables of weights and measures, whilst the French and German schoolboys, who will be in the future his principal competitors, are taught in a tithe of the time the simple decimal and metric systems, the whole tables of which are contained on a single page, and are given in just seventy-four words.

It is of course perfectly true that in most schools that have any pretension to give business training the metric system is also taught, but that fact only strengthens the arguments of those of us who favour the substitution for good and all of the metric for the British systems. It is clear that it is necessary for business men to have a knowledge of the metric and decimal systems, since they use it in their daily businesses, and when it is remembered that three-fourths of the countries of the world have adopted the metric system and that Great Britain deals with them all, the impossibility of escaping the use of it becomes at once apparent.

Many opponents of the compulsory adoption of the metric weights and measures say, "Although we are compelled to use the metric and decimal systems when trading with countries that have adopted those systems, why is it necessary to substitute those systems for our own since we can use *our own* for internal trade and *their own* for trading with them?" Strictly speaking, it is not *necessary*, but it would, as a moment's reflection must convince anybody, be infinitely more convenient. No one can deny that it would multiply work in factories to an enormous extent if two systems of weights and measurements were used simultaneously.

Even apart from the arguments that the metric system is used by almost every civilized country in the world, it would for future generations enormously facilitate commercial transactions. Every nation which has made a change in its weights and measures has adopted the metric—a fact which proves that it is considered to be on the whole the best. Commercial transactions should be facilitated as much as possible, and nothing can hinder them so much as a difference in the measures used for manufacture.

Compared with our heterogeneous jumble of weights and measures the metric system is simplicity itself. The meter is the unit of measurement, and is besides the basis of the

weights. Thus a cubic decimeter is the liter (or unit of capacity) and weighs one kilogram. A cubic meter contains 1,000 liters, and of course weighs 1,000 kilograms, or one metric ton. If the dimensions of any vessel are known, the weight as well as the volume of water it will hold is known also.

All that need be known of the metric system is as follows:—

Length.—Meter (m.) divided into 100 centimeters (cm.) or 1,000 millimeters (mm.). Kilometer (km.) = 1,000 meters. The meter is the fundamental unit of all metric weights and measures.

Surface.—Square meter, divided into square centimeters.

Bulk.—Cubic meter divided into cubic centimeters.

Capacity.—Liter (l.) divided into 1,000 cubic centimeters.

Weight.—Kilogram (kg.) divided into 1,000 grams. It is the fundamental unit of weight, and approximately it is the weight of one liter of distilled water at its greatest density.

Compare the above with our lengthy tables of weights and measures, most of which are forgotten by the boy a few months after he leaves school, and some of which are of no use to him from a practical point of view.

The Decimal Association has put forward a scheme of coinage, which is briefly as follows:—

It is proposed that we should adopt the florin as the unit of our monetary system, and that it be subdivided into 100 parts or cents, in which case it would be possible to retain the following coins:—

The sovereign as the 10-florin piece.
The half-sovereign as the 5-florin piece.
The florin as the unit or 100-cent piece.
The shilling as the half-florin or 50-cent piece.
The sixpence as the quarter-florin or 25-cent piece.

The new coins would be:—

A 10-cent piece about the value of 2½d.
A 5-cent. piece about the value of 1¼d.
A 4-cent piece about the value of 1d.
A 2-cent piece about the value of ½d.
A 1-cent piece about the value of ¼d.

It will be seen that there would be a slight difference, since there are now ninety-six farthings in the florin, whereas there would be one hundred cents.

This time of general upheaval is considered a suitable one for urging on this universally beneficial reform, as by so doing one of the greatest handicaps on the extension of our foreign trade would be removed.

§ 5 Cash Registers

THE Cash Register idea was conceived, as far as is known, in 1879, by a tradesman of the name of Jacob Ritty, hailing from Dayton, Ohio, U.S.A.

The fundamental aim of the cash register was that of enforcing a record of the money taken in over the tradesman's counter.

To the first principles of indication and simple recording have been added mechanisms which print, cut off, and issue from a roll of paper, tickets or receipts, printed with all manner of information that is indicated to the public, and automatically recorded.

The cash registers now work by electricity. A most ingenious electric motor has been developed to operate them. This saves the manual operation, and lengthens the life of the machines, because more uniform mechanical movement takes place than when worked by hand.

The National Cash Register Company have assisted the development of their machines very considerably by adopting principles of welfare and of educative work amongst their employees. Everything at the huge factory, which is a model of order and cleanliness, is done to encourage individual initiative and efficiency, and to give to all an opportunity to prove their worth. The principle of good health as a foundation to good work is taught and exercised. Safety devices, both mechanical and sanitary, are regarded as a first necessity. Prizes are given for suggestions, to encourage industry and talent.

The cash register, to be of value, must be perfect. It therefore requires the best of workmanship to build it. This can best be secured from people who are in every way interested in their work, and satisfied with their surroundings.

Educative principles are applied in marketing the machines. Thousands of agents, spread over the whole surface of the

globe, who sell National Cash Registers, are all trained in uniform principles of thoroughness.

§ 6 Automatic Time Recorders

THE invention and country of origin of the above is obscure. Their development, however, and present extensive use, must be accredited to the enterprise and ingenuity of America.

§ 7 Cash and Message Carriers

THE origin of some of the various types of carriers is obscure. It is, however, a fact that we owe the development and introduction on a practical scale of these labour-saving devices to America.

There are a number of types, amongst which ought to be mentioned the Pneumatic system and the Ball system, the latter having been invented in 1880 by Mr. Lamson in America.

§ 8 Fountain Pens

THESE were originated and developed in America, particularly the use of the gold nib, as being non-corrosive.

Important developments and improvements were made in rapid succession, the principal ones being the self-filling arrangement and also the safety cap. These improvements were due to American inventiveness.

§ 9 Pencils

AN entire revolution has taken place in Pencil Manufacturing, owing to greatly increased demands for lead pencils in the educational, commercial, and artistic worlds during the last quarter of a century.

The greatest developments have been made in Nuremburg, Bavaria, where, owing to Government assistance in stipulating that German products must be used exclusively by all public money-spending authorities, an industry was created so large

as to allow manufacturing in bulk to be carried on in that town.

Engineers specialized and competed with one another to improve methods of production, until the town became a world's centre for the supply of machinery, tools, and sundries for the pencil industry.

Meanwhile in England development has been slow, owing to the very severe competition which necessarily follows where goods are small in bulk, so that freights from the Continent are as low as an inland freight from British factories.

The centralizing of the industry on the Continent has also resulted in skilled labour being always available, whereas in this country it is necessary for each manufacturer to train his own labour.

The improvements in machinery have been of international advantage, the engineers who specialized in pencil-making machinery competing hard with one another in labour-saving devices.

There is no reason why the industry should not become large and important in this country if the Government will deal with the trade on the same basis that the Governments of Germany and Austria have done, by insisting that all public money-spending bodies shall purchase goods of home manufacture.

The energy and skill of the Continental dye and colour chemists and the assistance they have given to pencil manufacturers in their own countries have been a severe handicap to British firms.

The home manufacturer has had to rely on Continental supplies of dye and colour for his products, and has naturally not received technical assistance from the dye and colour chemists to the same extent as his Continental competitor.

The necessity for the scientific handling and development of the production of colours and dyes in this country is very marked in pencil making at the present time, where, owing to the shortage of supplies, there is almost a famine in certain classes of copying and coloured pencils.

It will be observed from this how dependent the British public have been in the past on Continental manufacturers for their supply of pencils, but there is no reason why this should continue if the Government will assist the industry in the manner previously indicated.

The British public can also determine its own source of supplies by insisting on being supplied with goods of British manufacture.

GENERAL ENGINEERING

§ 1 Automatic Machine Tools

THE fact that originality of design, and the bringing forward of new ideas in Machine Tool construction of all sorts have been largely due to American engineers is attributable to many causes. The American manufacturer has always been keen to obtain increased output and lower cost of production; this is best obtained by substituting power for manual labour. There has always been keen encouragement for a workman to use his head as well as his hands, and new ideas have always been sympathetically received by the master, who always allows the workman to benefit by the development of his ideas. The workmen know that originality and thought in devising more efficient methods are a sure road to advancement, and those who have shown these powers have been put into higher positions with increased wages.

The technical journals of America have encouraged workmen to contribute any ideas they may have, they themselves undertaking to write them up and make a proper drawing from the rough sketch, while courses of instruction from correspondence schools have been very popular. The results have been of immense value both to the employers and to the workmen themselves. The knowledge of these conditions has led to a steady emigration of skilled workmen from the Old World to the New. The American manufacturer has always been greatly helped, inasmuch as he is not troubled with the pernicious system of restriction of output on the part of the Trade Unions. The men have often struck for higher wages, but when they are at work they work to the fullness of their powers. The result has been that America has given the lead to the world in the development of automatic tools, and time and labour-saving machinery. The list appended will support this contention. No doubt some claims can be made,

though not many, that the ideas embodied in the machines are not original. This may be, but the question is who first made practical machines, and developed the ideas to the present degree of perfection and commercial utility. No claim is made that the American manufacturer holds the field to the exclusion of all others; there are firms in this country who produce similar machinery every bit as good, and, in some cases, better than their transatlantic neighbours, but the crux is the indisputable fact that the American engineer has produced by far the greatest number of labour and time-saving devices during the last twenty-five years or more. The fact that the English manufacturer can produce a similar article does not detract from the merit of being the first to put the ideas embodied into practical use.

LIST OF AUTOMATIC MACHINE TOOLS FIRST DEVELOPED IN U.S.A.

Turret lathes	America.
Automatic screw-machines	,,
,, chucking machines	,,
Multiple spindle automatic machines	,,
Milling machines	,,
High-power drilling machines	,,
Multiple spindle drilling machines	,,
,, ,, head for ordinary drilling machines	,,
Precision grinding machines, cylindrical, internal, and surface	,,
Tapping machines	,,
Magnetic chucks	,,
Drop forging machines	,,
Die casting machines	,,
Broaching machines	,,
Key-way slotting machines	,,
Filing machines	,,
Development of gearcutters	,,
,, micrometers	,,
,, gauges	,,
,, limit gauges	,,
Pneumatic riveting machines	,,
,, drills	,,

America first developed the modern scientific method of—

Laying-out works.
The use of run-ways in works.
The use of belt conveyors in works.

§ 2 Printing Machinery

By J. R. Riddell,

Principal of the St. Bride Foundation Printing School.

During the last twenty-five years many developments have taken place in printing machinery, and it must be admitted that, with a few exceptions, the machines in general use are those which have been developed, and not infrequently built, by foreign firms. In the newspaper section the greatest developments have taken place in America (with the exception of an English web-fed flat-bed machine for use in small offices), the improvements have been mostly in details, such as the fitting of additional decks or sections to the rotary newspaper printing press, improved folding mechanism to provide increased speed, automatic stapling by the machine and such details. Such developments also include improved "plate lock-up," inking adjustments, roller bearings, and the introduction of electrical control, all with the object of providing larger output at an increased speed. Composing machines have been brought to their present state of perfection mainly in America, as has also the invention of automatic stereotyping machinery, which has reached such a degree of excellence that no newspaper can afford to be without them, possessing as they do remarkable ingenuity, accuracy, and speed.

Similar conditions prevail in what is looked upon as the chief branch of the letterpress printing industry, *i.e.*, the jobbing section, where the requirements of commerce are dealt with, and where a multiplicity of types of machines are employed, most of which have been developed and perfected in America and Germany, including platens, stop cylinders and two-revolution presses, sheet-fed rotaries for high-grade magazine work, web-fed rotaries for book-work, multi-colour machines, automatic sheet feeders, and numerous other labour-saving devices, which enable the printer to obtain high output with minimum expenditure of energy. The British lithographer is indebted to America for the latest developments of the machinery he requires. The direct rotary and the off-set rotary are due to that go-ahead nation, although credit must be given to England for the designing and construction of flat-bed offset, and multi-colour litho machines. The latest improvements of machinery for the Graphic Arts have been made in Germany, where the rotary and flat-bed intaglio

printing presses have been constructed. This beautiful and ideal method of reproducing illustrations was worked in England as far back as 1895, but the method was kept a profound secret, and it was expensive and slow. In 1908 a German constructed a machine and developed it, perfecting a process of engraving which was quicker and just as good.

In bookbinding, America and Germany hold premier positions for supplying specialized machinery necessary for this work. In plate making, the machines as well as the delicate and costly screens for photo-engraving have been brought to a high state of excellence by America, though it is only fair to state that English-made process cameras, plates and filters, necessary for photo-mechanical processes, are unequalled. In the electrotyping business the highly-specialized machinery necessary to obtain the best results are the production of American and German developments. From this it will be seen that the Printing World has depended on countries other than England for progress in machinery, a fact all the more distressing when it is remembered that in high-class printing this country is supreme.

A short list of modern printing machinery in general use in the United Kingdom is appended, together with the country where the greatest developments have taken place:—

Newspaper Machinery:	
Rotary presses (web)	America.
Composing machines	America and Germany.
Stereotyping (automatic)	America.
Electric control	,,
Letterpress Printing (commercial):	
Platen presses	Germany and America.
Cylinders (two revolution)	America.
Rotaries (sheet fed)	,,
Rotary (web)	Germany and America.
Multi-colour presses	America.
Lithographic Printing:	
Direct (rotary)	,,
Offset (rotary)	,,
,, (flat bed)	Great Britain.
Multi-colour presses	,,
Intaglio Printing:	
Mechanical gravure (flat bed & rotary)	Germany.
Electrotyping:	
Specialized machinery	America and Germany.

Photo Engraving:	
Machinery and screens ..	.. America and Germany.
Process cameras and plates..	.. Great Britain.
Book-binding:	
General machinery	.. America and Germany.

§ 3 Tanning Machinery

THE machinery used in tanning is a good illustration of the contentions of this book. The making of leather is an industry which can be traced back to the earliest times. In the manufacture of heavy leathers England has always held an honourable position, and is probably still the leading producer as regards quality.

When the manufacture of other types of leathers is considered, there is a very different state of affairs. The lead has passed to other countries; America and Germany lead in the production of chrome leathers. Finally, in the designing and development of labour-saving machinery England has been left far behind, and it is to American genius that the world owes the great improvements which have been introduced.

A list is given which will support this statement.

A typical example of the saving which can be effected by machinery is found in the fleshing and unhairing machines. Until they were produced these processes had to be done by hand, and a skilled man could perhaps flesh and unhair twenty-five hides in a day. Various attempts have been made by American and German manufacturers to perform these processes by machinery. The difficulty was always found that, with a hard roller, when an inequality occurred, the hide was cut by the knives, and its value was depreciated. After considerable thought and experiment, an American inventor produced a machine with a practical pneumatic roller, in which the pressure could be regulated at will. The problem was ended. These machines, worked by two men, will deal with three hundred hides or more in a day, and they can be set to produce a hide of any uniform degree of cleanness regardless of the varying thickness of the hide or hides passed through.

Another example is the band-knife splitting machine. This has absolutely revolutionized the splitting of hides, and immediately made all other types more or less obsolete. Perhaps one of the most remarkable examples of American genius is the measuring machine. In this the hide is passed between a

long bottom roller, and a series of wheels. The hide is, of course, uneven in shape, and whenever it touches these wheels they are caused to revolve; they actuate a calculator through levers, and the area of the hide is given to a few square inches.

The introduction of these various machines to the English market led to their immediate adoption, and in most cases the manufacturers of tanning machinery in this country produced similar machines to meet the demand; in some cases, of course, they cannot do this, because of the patent rights.

The reasons why the English manufacturers did not produce these machines is not far to seek. It is a characteristic of this nation that we are conservative and slow to change, and as a result there was no demand from the tanners for new machinery.

They were not disturbed in their own market; English heavy leather has a good reputation and they could sell what they produced. The more active American mind, however, is always eager to try a new idea, and new machinery found a ready market.

Hence the manufacturer had an incentive to exercise his ingenuity in producing what was required. When new methods were produced the English tanner found that he must change with the times, or be left behind, and they were quickly adopted in this country.

List of some of the chief machines used in tanning, and their countries of origin:

Fleshing machine	America.
Unhairing machine	,,
Modern scouring machine	,,
Band-knife splitting machine	,,
Drum machine	,,
Bleaching machine	,,
Cutting-out machine	,,
Modern rolls of all types	,,
Shaving machine	,,
Seymour-Jones attachment	Gt. Britain.
Staking machine	America.
Modern Jacks glazing machine	,,
Blacking machine	,,
Seasoning machine	,,
Horizontal embossing machine	Germany.
Buffing machine	America.
Whitening machine	,,
Power hydraulic press	,,
Measuring machine	,,

§ 4. Boot and Shoe Machinery

OWING to more favourable conditions and the absence of established practice, the United States were placed in the van of all Shoe Machinery progress up to about the year 1895. In this year the British industry was revolutionized, following what is known as "the great strike," in that the system of making footwear entirely under the roof of the manufacturer (instead of at the homes of the workers) became general.

The sole-sewing machine was exhibited at the 1861 Exhibition in the Crystal Palace, and even in the early part of that century Brunel invented shoe machinery which was used by the Army Clothing Department at Pimlico. But the need for footwear, particularly for the Army, was greatest when labour was short, and it was during the American war that an inventor named Auguste Destouy invented a curved-needle machine, which was the forerunner of the now famous American Goodyear system.

Later on America introduced what are known as finishing machines, which are, as a matter of fact, an adaptation of well-known mechanical devices used here in metal polishing for many years. These American machines were faithfully copied in Great Britain so far as their mechanism was concerned, and it is safe to say that the engineering methods were much improved upon here. The American machines in the 'nineties were very crudely built, and British engineers who entered the field not only made them better but added considerable improvements to them.

It would seem as if the sale of machinery outright was at one stage not sufficiently profitable to allow of proper attention being given to the shoe manufacturer after he had purchased a machine. The big American companies joined hands and were able to keep a large staff of expert operators, investigators, and experimenters. They were alert enough to buy up any promising invention, and it looked as if they would be able to monopolize the shoe machinery business in Great Britain, as they had done to a very great extent in the United States. The American system of placing machinery out on "Royalty" was profitable and beneficial to the combine; it was able to buy up most of the improvements in shoe machinery which survived the experimental stage, and with its well-organized staffs to demonstrate their utility in actual

practice. Against the "Royalty" system the British engineers outside the combine are however able to produce rival machinery of such a quality that they easily compete with the American combine. Some of these firms are able to supply an entire plant for the production of footwear, and are at the present day not only doing so in this country, but were so doing in pre-war times in our Dominions Oversea and on the Continent.

There is undoubtedly evidence that inventors have received greater encouragement and financial assistance in the United States than in this country. It is on record, for instance, that Keats, an able inventor of a stitcher, through lack of encouragement here, transferred his abilities to Frankfort-on-the-Main. Calgau of Gloucester put up a set of machinery in Leicester, but his enterprise ended in failure through lack of encouragement.

The question as to "Royalty" versus "Non-Royalty" machines, that is, the American practice as distinct from the British practice, hardly arises here, but it can be confidently stated that in the matter of *manufacture*, whilst the Americans have given the British engineers a lead, there is no lack of competition against them here, and it is a fact that the largest boot and shoe factory in England does not use "Royalty" machines.

British engineers are holding their own, and there are few concerns that are not making headway, although not to the same extent as the Americans with their superior combination.

It may be said in conclusion that the dominating factor in boot and shoe machinery has been American, and that the output of such machinery in America is far greater than in any other country. This position has largely been won and maintained by combination, and by the employment upon a large scale of experiment and research in the interests of the industry.

Since the adoption in Great Britain of the American system of Lasts in the manufacture of boots and shoes we have fairly held our own in the home and export market. As in machinery, so in the finished article, America led the way.

Boot and shoe machinery	..	..	..	America.
Modern system of lasts	..	..	..	.. ,,

§ 5 Shipbuilding

In the sphere of equipment of Shipbuilding Yards, most of the outstanding changes with respect to transport and weight-lifting facilities in particular, but plant in general, are traceable to foreign sources. For instance, in the case of large shipbuilding yards building modern warships, where very heavy lifts such as gun-barbette machinery, armour plates and guns, had to be undertaken, the original form of cranes, *i.e.*, Sheerlegs, were found to be quite inadequate besides being slow and cumbersome.

The Germans had, for some time, been employing what has now come to be known as the "hammer-head" type of radial crane. Subsequently cranes of this type supplied by German firms and erected by German workmen were installed in four of the largest shipbuilding yards in Great Britain.

The same thing applies in the case of wood-working machinery, except that in this case highly specialized American machinery has replaced the less efficient British article.

It is only fair to add that, with regard to cranes—the very large types especially—the British firms have now taken a firm grip of the business, and in one case at least the German article has been scrapped in favour of a more substantial British design.

Generally speaking, a modern shipbuilding establishment is equipped with foreign-designed plant to a very large extent, and the undernoted list will give a rough idea of the division as between British, American, and German machinery.

Heavy shipyard machinery, such as punching and shearing machines for plates and angles, etc.	Great Britain.
Heavy engineering machinery, such as lathes, etc.	,,
Light engineering machinery, such as high-speed drilling machines, milling machines, etc. ..	America.
Heavy wood-working machinery for working logs, etc.	Great Britain.
Light wood-working machinery of all kinds ..	America.
Cranes, gantrys, etc., for lifting heavy weights..	Germany.

The subject of Turbines may not come within the purview of this note, but it is now a matter of common knowledge that the American-designed Curtis turbine associated with the

Parsons' system of gearing has been largely taken up in this country, especially in high-speed warships. It is also a matter for regret that, at the time war was declared, we were fitting on our latest warships a Gyro-Compass of German design, made under licence by an English firm. The outbreak of war, of course, compelled us to find another type, and we had to adopt the American article.

Until recently the mechanism for the closing of water-tight doors in a ship was the monopoly of two firms—both foreign. The Stone-Lloyd (hydraulic) system is a German scheme, which has been taken up and developed by a British firm, and is at present the system most fitted in this country.

The other design is an electrically-operated system, known as the "Long-Arm" system, and is the method adopted in America, being also manufactured by an American company.

These two designs are the only forms of water-tight door control which may fairly be classed as in common use, and as will be noted, both of them are in the hands of, or controlled by, foreigners.

Turbines	.. Great Britain and America.
Gyro-compass ..	.. Germany.
Water-tight doors	.. Germany and America.

§ 6 Paper-making Machinery

PAPER is made from all kinds of vegetable cellulose, employed in the early days in its most mature and hardy form, principally linen, jute, and cotton rags. As the consumption of paper increased, recourse was had to other forms of cellulose, which, although inferior in strength and quality, existed in greater quantities. Principal amongst these are the various forms of cellulose obtained from wood both by mechanical and chemical processes. The introduction of wood has called for special plant for its treatment, and the development of this plant has naturally fallen to those countries where wood of a suitable kind is found. Plant for the preparation of cellulose from wood has therefore been mostly invented and designed in Norway, Sweden, U.S.A., and Canada, although even in this branch of paper-making many English and German names are found as inventors, such as Partington, Mitscherlich, Kellner, etc.

Next to wood pulp, the most important of the newer materials introduced into paper-making is esparto. Although esparto is not found in this country, the development of the plant to treat it has taken place entirely in Great Britain, which is to-day the principal user of this important and valuable fibre. The pioneer in the use of esparto for paper-making purposes is Mr. Thomas Routledge.

As regards the paper-making machine proper, it is in all essential points the same as when originally invented by Fourdrinier over a hundred years ago. Improvements in the machine have consisted mostly in the perfecting of the mechanical details, and increases in the width and speed, particularly in the last twenty-five years. During this period the speed of machines making "news," and the cheaper qualities of paper, has been doubled, whilst the width of the largest machines has increased from 140 inches to 210 inches. The initiators of the movement in the direction of increased width and speed were the Americans. This development was due to a more general standardization of paper sizes and substances, which enabled paper machines to have long and continuous runs. An important new feature of the paper machine, which makes possible the high speeds of to-day, has been the raising of the wire end of the machine, until its declivity causes a flow of pulp equal to the speed of the machine. This was the invention of an American, Mr. Eibel, although experiments in this direction had been made previously in this country. In order to minimize the great wear and tear of the wire on the paper-making machine, many attempts have been made to design a revolving suction box. The most successful of the kind is one which is worked in the position of the bottom couch roll. It was invented by W. H. Millspaugh of America and is in almost universal use in that country.

Great improvements have been effected in the driving of paper machines, the principal of these being the dividing up of the drives of each machine into two groups, driven independently of each other, one for those sections of the machine which run at a constant speed, and the other for those which require to vary in speed according to the thickness of the paper made. Speed-changing devices of many kinds have been designed for adjusting the speeds of the various sections of the paper-making machine in their relation one to another. The last twenty-five

years have undoubtedly marked a great advance in the driving arrangements. Most of these improvements in driving have come from the U.S.A. and Great Britain, such as the "Marshall" drive, the "White" drive, the "Lloyd and Hutchinson" drive, etc.

The general distribution of power throughout the paper mill has had considerable attention. Electrical driving has come very prominently to the front during the last few years, beginning with those countries where cheap electrical power generated by water is available. Great heat is required in paper mills for boiling and drying purposes, and a close combination is now made between the heat and power arrangements in the different departments of the mill, in order to obtain from the steam its maximum output of heat and mechanical energy. Inventions and appliances relating to steam economies belong mostly to Great Britain.

The auxiliary machines used in preparing the different pulps, such as beating engines and refining engines, have provided inventors of all countries with great opportunities. During the period under survey, beating engines of many kinds have been produced, the new inventions being fairly equally divided over the various paper-making countries. For general work, however, the old hollander (the original beater) is still considered the best. Refining engines, or continuous beaters, had their origin in America, in the shape of the "Kingsland," "Jordan," and "Marshall" engines. Newer inventions in respect to these refiners belong to Great Britain, such as the "Pearson-Bertram," "Nuttall-Seddon," etc.

In the straining and cleaning of the pulp, prior to running it off on the paper machine, the old jog knotter, particularly for short wood fibres, has been superseded by the rotary strainer invented by Wandel of Germany. The rotary strainer has been further developed and improved by Reinicke and Jasper, Voith (also of Germany), and Partington (British). White's oscillating strainer (British) has also had considerable success.

Large amounts of water are used in the manufacture of paper, and many appliances have been devised for treating the backwater in such a way as to recover the fibres and other paper-making materials. The most important inventions in this connection are the "Fullner" Gravity Filter and the "Fullner" Felt Filter (German).

The revolving cutter is the standard cutting-machine of Great Britain and the U.S.A., whilst stop cutters are most generally adopted on the Continent. Each country has made great improvements in these particular types of machines, the British inventions including the "Partington" duplex cutter, and the "Vickery" and "Collis" layboys for catching the sheets.

With regard to reeling machines for slitting and winding the paper into the various widths and diameters, the principal inventions in later years for "news" and "printings" have been the "Warren" and "Moore and White" (U.S.A.) and for reels of small diameter in narrow widths the "Bischoff" (German), "Cameron" (U.S.A.), and tape machines "Jagenberg" and "Goebel" (German).

The development of the super-calender belongs principally to Germany, as also do the principal improvements in this machine in recent years.

Germany manufactures the greater portion of machinery used in the enamelling and coating of paper. As a natural consequence most of the improvements in this class of machine have had their origin in Germany.

Principal Machines.	*British.*	*American.*	*German.*
Pulp-preparing plant	Partington.	Numerous.	Mitcherlich Kellner.
Esparto development	Routledge (Pioneer).	—	—
Pulp concentrator ..	Cooper.	—	—
Paper machine ..	—	Eibel. Millspaugh.	—
" " ..	(Drive) White, Lloyd & Hutchinson.	(Drive) Marshall.	— —
Auxiliary Machines.			
Refiners	Nuttall & Seddon. Pearson & Bertram.	Jordan. Kingsland. Marshall.	—
Strainers	Partington. White.	—	Reinicke & Jasper. Voith. Wandel.

Auxiliary Machines (contd.)	*British.*	*American.*	*German.*
Backwater filters ..	—	—	Fullner.
Cutters and layboys	Partington. Vickery. Collis.	—	—
Reelers	—	Warren. Moore. White. Cameron.	Bischoff. Goebel. Jagenberg.

§ 7 Tobacco Machinery

In this industry most of the machines used for preparing and airing the tobacco and afterwards making cigarettes are of American origin. Modern drying and steaming machines are the products of American invention. The presses used are obviously the result of adapting existing types of presses for the special requirements of the trade, and cannot be attributed to any particular country. The marvellous machines which turn out completed cigarettes in such numbers are developments of the "Bonsak" machine, an American production, and of a German machine which completed the cigarette by pleating the paper instead of sticking it with paste. The latter is not much used now. The only prominent English machines are those used for cutting the tobacco. These are the best machines made and are used all over the world.

Preparing machines	America.
Airing and drying machines ..	,,
Steaming machines	,,
Cigarette-making machines ..	America and Germany.
Tobacco-cutting machines ..	Gt. Britain.

§ 8 Cement-making Machinery

The original machinery used by cement manufacturers in this country was of British design and construction, and it was not until twenty years ago that any steps were taken to develop it. At that time, two important inventions were brought out, *i.e.*, the Tubemill system of grinding and the Rotary Kiln system of calcining. The first of these, the Tubemill system, was the invention of a Dane, the Continental sale being controlled by, and the machines made in, Denmark.

Following on the inception of these new machines, Germany was soon appreciative of their utility, and subsequently,

quite regardless of any patents, commenced to manufacture them. Powerful influences were at work in Germany, the result being that after considerable litigation the patents were found to be " invalid " there.

The keen competition of the Germans, who were willing to sell at almost any price to cut out English firms, soon gave them the lead as makers of cement plant. These cement-making mills can only be economically produced if a large number are made at one time. Germany was soon aware of this, and turned out the machines wholesale, building huge factories for this purpose. English firms did not follow this example, as they had only their own market, and even this was subject to strong competition.

The rotary kiln was invented by an Englishman, but the clinker produced could not be dealt with satisfactorily until the Tubemill was brought out. This kiln was improved and developed by America, though the British and German cement manufacturers were experimenting about the same time. A rotary kiln is a very expensive piece of machinery, although there is not much difficulty in designing it, as it is very simple; but here again England was confronted with a new phase of German competition. The method adopted by the German firms was to come over here with an offer to install these expensive machines, and to accept as payment a certain number of shares in the concern. British engineering firms making the same machines were not in a position to do this, as the necessary financial assistance was lacking.

The combined result of the two processes was that, if a new cement plant was to be installed in either this country or any other (except the States), the German firms offered to find the whole of the grinding plant and kilns without receiving a cash payment of any kind. Usually however they wanted fifty per cent. of the shares in the company, and very soon had control of the whole.

This meant that only in rare cases were the British firms able to pick up orders, and then only for single machines.

In a word, this is essentially an industry, the machinery for which has had its origin and development mainly abroad, due to the causes cited rather than to any greater scientific or mechanical skill on the part of the foreigner.

Tubemill	Denmark and Germany.
Rotary kiln	Gt. Britain and Germany.

§ 9 Paper-Box making Machinery

THE great developments in Box-making Machinery in recent years are largely a record of American ingenuity.

This is due principally to the very much greater use made of cardboard boxes in America than in this country, but also to some extent to the home-work system which still prevails here, and which even now makes the position of the well-equipped factory very difficult.

The rapid developments of paper-box making machinery which have taken place in the United States during recent years have been due to the pressing necessity of keeping pace with the rapidly growing demand for cardboard boxes, and it is only within the last few years that these developments have spread to other countries.

There is only one branch of the trade in the development of which this country has taken a very prominent part, that is, the making of round boxes. This a highly specialized trade, in which expensive machinery is essential, and this country has kept well to the fore in its development.

Cardboard-box making machinery can be roughly divided into several headings. The attached list will give a very good idea of its origination and development.

	Machinery Originated.	*Recent Developments.*
Carton making	Germany	America.
Wire stitching, metal edging, etc.	„	„
Corner staying	America	„
Paper covering[1]	„	„
Corrugating	Germany	„
Round box making	Gt. Britain	Gt. Britain & America.
Heavy machinery for fibre-board packing cases	America	America.

§ 10 Match-Box Making

BEFORE 1887, the match-boxes were cut out by a simple English Skillet cutting machine and finished by hand, the cost per gross under this system working out at 5½d. In addition several Swedish box-making machines had been tried

[1] *i.e.*, covering the rough box with paper (generally glazed).

but without success, hence the result that hand-made boxes were considered to be the best form of manufacturing.

In 1900 the Americans introduced into this country a high-speed cardboard-box making machine, which made the outer part of the box and printed it complete at the rate of 700 per minute. They also introduced a machine to make the drawer to fit the outer cover. This machine gave an output of seventy-five drawers per minute at a cost of 1½d. per gross. These boxes were then filled, and put on the market at a very low figure, with a view to killing the trade in the hand-made boxes. For a time a dozen boxes of matches in machine-made boxes could be obtained at 1d. per dozen less than the price charged for matches in hand-made boxes, but as the cost was only 4d. per gross less than the hand-made box the manufacturers had to increase the price. They tried to bring it up to the hand-made box price, but it was not possible to do this. To-day its sale is very small indeed.

During the last few years many manufacturers have used a machine patented in Sweden. This box-making machine will take either millboard or wood, and produces a box equal to any hand-made. The output of each machine is 200 gross of complete boxes per day; there is practically no waste; the cost per gross is 4d., or 1½d. under that of the hand-made, and it requires very little attention to keep in going order.

There is no English box-making machine obtainable.

Match-box making America and Sweden.

§ 11 Match Making

BEFORE 1875, very little machinery was employed in match-making in this country, all splint cutting being done in America and Russia, the "dipping" and boxing only being carried out in England.

The splints were cut into lengths of 4in. and 5in., and the machines used to separate these and place them into position for receiving the composition were principally made of wood, driven by power, and were known as "Rocking" machines. These machines could be made by any skilled carpenter, and the output of each was about fifty gross per day. The cost then was about 5d. per gross for "dipping," filling and boxing.

An improved type of machine of English make was put upon the market in 1878 (the patentees are not known). It was an exceedingly smooth and economical machine to work, and was commonly called a "Bowling" machine. The production was ninety gross boxes of matches per machine, which brought the cost down to about 3d. per gross. In one room of a large match-making firm 180 of these machines were running, and it only required two mechanics to keep them in good repair.

In 1900, an American firm came to England to endeavour to control the whole of the match-making industry. They brought over a "continuous" machine which was fed with blocks of wood, size about 3in. by 2½in., these being cut into splints, "dipped," boxed, and turned out complete at the rate of 700 gross per day, at a cost of about 2d. per gross. At first however these matches were very unsatisfactory on account of the badly cut splints, but they were put upon the market at a price which no English manufacturer could compete against, and consequently for the time being secured the monopoly of the trade. Eventually it was brought home to the English manufacturer that, in order to compete with the Americans, he must adopt a machine giving the greatest output and at the same time a more satisfactory article at an equal price. To endeavour to do this a Swedish machine, invented by a man named Roller, was taken up. This machine is fed with ready-cut splints, and although the output is only 350 gross per day the finished article is much superior to the American machine-made match, which enables the English manufacturer to hold his own in this and other markets. The Roller machine is used very largely to-day with good results.

It will be seen from the foregoing that the machinery of match-making has been given to the world by countries other than our own.

Match making .. .. .. America and Sweden.

§ 12 Aluminium

THE growth of the Aluminium industry has been most interesting, as although such a substance was foreshadowed in the beginning of the nineteenth century it was not until about

twenty-five years ago that aluminium was produced in bulk, at which time the process of manufacture achieved commercial success. Various countries were at work on this elusive commodity, and we find that in this, as is the case with other developments involving research work, Germany was well to the fore.

About this time, Germany, America, and France took out patents for the electrolytic extraction of aluminium; subsequently these patents were largely developed by America. Since then, the production of this metal has increased by enormous bounds, and the demand consequent upon its reduced price has more than kept pace with this increase.

With regard to the use and development of aluminium, America has done more in applying it to electrical practice than any other country; otherwise all countries use this metal more or less to an equal degree.

Electrolytic extraction .. Germany, America, and France.

§ 13 Ball Bearings

THE use of ball bearings, to any considerable extent at least, coincided with the advent of the bicycle.

Their introduction met at first with a fair measure of success, chiefly owing to the fact that the load was comparatively small and the speed low. When however their application was extended to machines of greater dimensions, the results, owing to the increased speed and higher load involved, and perhaps still more to faulty construction or unsuitable material, did not prove equally satisfactory.

A few years ago Professor Stribeck, head of the Technical Laboratories at Neu Babelsberg, near Berlin, discovered that, providing the design of the bearing and the steel from which it was manufactured were of sufficiently high grade, bearings could be used for much heavier duties. It was conclusively proved that bearings so constructed would stand a considerably higher specific load.

It is to be noted that designers in this country have not taken the lead in these developments, being apparently satisfied with what might seem the more prudent course of following the experiments of other nations. The foreigner on the other

hand has not been slow in realizing the many advantages to be obtained through the adoption of ball bearings. It is only in recent years that British manufacturers have begun to appreciate their value.

Improved ball bearings .. .. Germany.

§ 14 Oxy-Acetylene Welding

THE discoverer of Acetylene, a beautiful white light, or at least the first to report on it, was Mr. Edmund Davy, Professor of Chemistry of the Royal Dublin Society in 1836. It remained very little known except as a laboratory product until the French Professor Berthelot published his researches in 1860, wherein the name Acetylene was first given to the new gas. He published results of further research in 1862, in which year the German chemist, Woehler, discovered calcic carbide, and first used the term carbide of calcium. Though interesting laboratory experiments were reported from time to time by Berthelot and other French, Continental, and British chemists, the commercial possibilities of carbide and acetylene were undeveloped until in 1892, when a Canadian, Mr. Thomas L. Willson, working in Spray, North Carolina, discovered and patented his process for the production of carbide. Almost simultaneously, Henri Moissan of Paris had been experimenting, and reported on a process of production, but he generously waived any claim to priority in commercial manufacture in favour of Mr. Willson.

Meantime in 1889, Mr. Thomas Fletcher, of Warrington, demonstrated the possibility of fusing metal with oxygen and coal gas.

Twelve years later the same process was applied on a practical scale by Dr. Menne, of Germany.

The application of acetylene with oxygen for welding on sound lines has however been due to the exhaustive experiments of the French, though Germany promptly appropriated, as usual, the results of their neighbours' research.

British and American developments of the industry, though originally indebted to France, have broadened out on independent lines. Some of the results of American enterprise in this connection, notably in heavy railway and pipe work, have

been published, but the official censor screens from public view what utilization has been made of the new craft in the interests of the British nation.

Carbide of calcium	Germany.
„ „ „	Developed commercially in America.

CIVIL ENGINEERING

§ 1 Town Planning

Town Planning is a very ancient art—at least as old as the Babylonians, and at intervals throughout history there have been recurrent attempts to provide for wise town development.

After the Great Fire of London in 1666, both Sir Christopher Wren and John Evelyn prepared very complete plans for rebuilding the City, but even in those days the City Fathers thought it was too late to do anything with London, and the plan was dropped.

In the middle of the eighteenth century there was again a revival of town planning ideas, and the planning of such towns as Bath and of the squares in the West End of London dates from that period.

On the Continent, many of the ruling princes took a keen interest in the planning of their capitals, and such towns as Mannheim and Karlsruhe are striking examples of towns planned as a whole, the former on a rectangular, and the latter on a radiating, or "cart wheel," plan.

These towns were however planned a couple of hundred years ago, and the modern movement in favour of town planning began in the last quarter of the nineteenth century. Sweden adopted a town planning Act in 1874, Italy in 1865, Prussia in 1875, but it was not until 1909 that the new ideas found a firm footing in England under Mr. John Burns' Town Planning Act of 1909.

The origin of the modern garden city movement was in the first instance due to Mr. Ebenezer Howard, and his ideas have been widely followed both in England and on the Continent.

In town planning proper however we have still much to learn from experience elsewhere.

§ 2 Steel-Framed Buildings

THE system of steel-framed buildings, that is, where the building is held up by its frame and where the brick-work is merely panelled in, was originated, and developed in America, firstly in Chicago, but more particularly in New York, where land is very expensive, and the advisability of erecting taller buildings was accordingly more speedily recognized. The pure or absolute theory was developed in England, but America and the Continent have to a great extent adopted the method of designing which allows of their structures being statically determined, that is, the loads on the main members are ascertainable.

With regard to experimental and research work, both America and the Continent have done practically all the pioneering, whilst England has relied principally upon their experiments.

In 1889, there was not a single tall building, known as a "sky-scraper," in the world; to-day there are scores of them in American cities, the heights varying from seven stories up to fifty, and even beyond. These buildings developed rapidly, and owing to the necessity for the economic use of land were soon in public favour.

With the inception of tall buildings came the modern elevator, and whilst the elevator has made the sky-scraper a possibility, the sky-scraper has in no less degree developed the elevator.

It is interesting to note that, following upon the evolution of this new method of construction by America, nearly all large city buildings in Great Britain are now erected on the American steel-frame principle.

Ferro-Concrete Construction (also of foreign origin) is widely used, the two forms of construction combined having revolutionized British methods.

Steel-framed buildings	America.
Experimental and research work	America and Europe.
Ferro-concrete construction ..	America.

§ 3 Re-inforced Concrete

IT is probable that the first patent with respect to the combination of iron and concrete, which is now known as re-inforced concrete, was taken out by a British subject, Mr. Wilkinson, of

Newcastle, in the year 1854. The development however of this form of construction was almost entirely confined to the Continent and the United States of America until approximately the commencement of the present century when some of the Continental firms started branches or agencies in London. Its use in this country continued to be very restricted until about 1904-5, since which date its employment has gradually increased.

Most of the firms now specializing in re-inforced concrete in Great Britain, and holding more or less controlled patents, are of American or Continental extraction, but year by year the industry is spreading and becoming more under the control of the British firms.

With respect to the scientific developments, the experimental investigations on which the design for structure are largely based have been, up to the present time, almost entirely carried out abroad. In America, France, Germany, Austria, and other countries, the Universities, and in many cases the Government Departments, have instituted experimental work of an extremely useful and interesting nature. Professors and Government officials have analysed the results of these experiments and published their conclusions in Government papers and reports and similar publications.

In Great Britain any work of an experimental nature has been carried out almost completely by private enterprise, without any help from Government Departments or public or semi-public funds. The consequence has been that up to the present this country has been almost entirely dependent upon foreign information with regard to problems arising from the development of the Re-inforced Concrete Industry.

Ferro-Concrete, or Re-inforced Concrete, is a matter almost entirely of scientific design. The work is carried out by contracting firms of builders in accordance with furnished particulars.

The term Ferro-Concrete, or Re-inforced Concrete, denotes the method of constructing with steel and concrete in such a way that the steel takes the tension stresses, and the concrete the compressive stresses. A new building material of great strength, lightness, durability and low cost is thus provided. The terms Ferro-Concrete, or Re-inforced Concrete, are also employed as descriptive of the finished article.

Ferro-concrete and Re-inforced concrete	.. ..	Gt. Britain, developed in America, France, Germany, and Austria.

§ 4 Central Heating

ALTHOUGH the idea of Central Heating appears first to have been introduced by James Watt nearly a century ago, its development on commercial and popular lines has taken place almost entirely within the past twenty-five years, chiefly in the United States of America, and on the Continent of Europe.

At first, the hot-air system with a stove fixed in the cellar or basement, with large pipes or ducts conveying to the various rooms the air heated by contact with the metal walls of the furnace, was generally adopted.

About twenty-five years ago, the modern cast-iron radiator was brought out in the United States of America, and owing to the known advantages of low pressure, hot-water, and steam heating, this has gradually led to the wide adoption of these methods throughout that country. They are now installed in a large proportion of new buildings as well as in many thousands of modernized old buildings. This is also true of Germany, where the scientific side of central hot-water and steam heating has been studied with characteristic thoroughness. In all other European States, except Russia, central hot-water and steam heating have also made great and rapid progress.

Although radiators and pipe coils of clumsy and heavy design have been made in England on a small scale for many years, the modern radiator was first imported from America between twenty and twenty-five years ago. Later on in this country the manufacture of radiators of the American type was taken up by some of our iron founders. In 1906, large works were built in the North of England specially for the manufacture of radiators and boilers for central heating. The importation of heating apparatus of this character from America has now practically ceased, but up to the outbreak of war a considerable quantity of such material was imported from Germany.

Central heating .. .. America.

§ 5 The Automatic Sprinkler

THE idea of extinguishing fires by means of a mechanical device, operated automatically by the heat of the fire itself, was

originated by John Carey, an Englishman, in 1806, and subsequently improved upon by others in England, including Sir William Congreve, William Maccaboy, Louis Roughton, and Captain A. Stewart Harrison. But the first automatic sprinkler to be put to practical use was invented in 1875 by Mr. Henry L. Parmelee, of Newhaven, Connecticut. After a good many vicissitudes, he placed upon the markets of America and Great Britain the Parmelee sprinkler, which, though a long way behind present types as regards sensitiveness, was a practical and workable device. It was this device which in 1880 received from the New England Insurance Company the first recorded endorsement given to an automatic sprinkler, carrying with it the grant of substantial reductions in the premiums upon buildings in which it was installed.

Meantime Mr. Frederick Grinnell, the Chief Mechanical Superintendent of the Erie Railroad, attracted by Mr. Parmelee's experiments, set to work to produce a mechanical device which would correct the known defects of previous types. As a result, Mr. Grinnell in 1882 gave to the world his epoch-making invention, in which he embodied the entirely original idea of utilizing the same element of hydrostatic pressure to keep a water valve tight as to force it open. Up to that date, water valves had only been held closed by the employment of counter pressure mechanically applied, whereas in the " Grinnell " valve, set in the centre of a flexible diaphragm, the water pressure itself made its own joint *so that the greater the pressure the tighter became the valve,* thus eliminating for all time the risk of leakage. This type of sprinkler has never been improved upon, and holds the market to-day.

From the foregoing, it will be seen that, whilst the idea of utilizing the heat of a fire to bring about its own extinction originated in the brain of an Englishman, and was carried through many stages of improvement by other Englishmen, the practical solution was left to America.

There is however one most important and vital portion of a sprinkler installation, to which England can lay sole claim, namely, the invention of the Automatic Alarm Valve, in which the upward flow of water to the sprinkler pipes is utilized to give a loud and continuous alarm of fire. This was the invention of Mr. John Taylor, an Englishman. It was quickly taken up by America, and, next to the sprinkler head, has done more

than anything else towards the development of the art of automatic fire extinction.

Automatic sprinkler	America.
Automatic alarm valve	Gt. Britain.

§ 6 Lifts, Escalators, Collapsible Gates

ACCORDING to the MS. journal of a tourist dated October, 1777, describing the house of Empress Theresa, we learn that it contained a "curious machine" by which the Empress "who was too stout to go up and down stairs" was conveyed through a well from one floor to another to the top of her house. This is probably the first record we have of the Passenger Lift or Elevator, though no doubt some form of hoist had been used for many years in the mining industry.

Professor Bond, the first director of Harvard College Observatory, U.S.A., constructed a small platform, controlled by block and tackle by the occupant, for conveying passengers to and from the observing room and the dome. After the lapse of several years, Otis Tufts built the famous "vertical railway" in the Fifth Avenue Hotel, New York, which was the parent of the modern passenger elevator. In the *Penny Magazine*, 1835, an illustration is given of the early type of passenger lift, but it was not until 1871 that the hydraulic elevator was produced in America, followed by England a few years later, one of the first prominent installations in this country being in 1880 at the Grand Hotel, Charing Cross, London.

In 1888 America again forged ahead of us by the development of the electric elevator, it being two years later when we exhibited the first lift of this type at the Crystal Palace, London. Towards the end of the last century the automatic push button lift was introduced first in America, and then in England. A lift was thus constructed which can be controlled quite easily by a child by the simple pushing of a button similar to an electric bell push.

When the late Mr. Yerkes came from America, he brought with him a staff of engineers to conduct his scheme of electrification of the District Railway and construction of three new "Tube" railways—Charing Cross and Hampstead—Baker Street and Waterloo—Hammersmith, Piccadilly and Finsbury Park. These engineers realized that, if transit in London was

to be made as speedy as possible, it was not only necessary to bring the platforms within easy access from the street, but to lose as little time as possible in loading and discharging from the lifts. They introduced the American pneumatic opening and closing device, which enables the doors and gates at the other end of the lift to be controlled by the attendant, while remaining by the switch to raise or lower the lift. This overcame the great difficulty experienced by the Central London Railway, where every passenger desired to be the last o enter the lift in order to be the first out.

About ten years ago the "Escalator" was introduced into England. It had been successfully adopted in America six years before (1900), and perfected there by American engineers. The "Escalator" is popularly known as the Moving Staircase.

Lifts, escalators, collapsible gates .. .. America.

MINING ENGINEERING

§ 1 Mining Engineering and Smelting

In this as in other industries the lead in up-to-date methods was given by America. The mechanical processes of mining in this country have failed to give many new ideas to the world, and modern methods have been mostly developed abroad. In coal mining, mechanical cutting was commenced commercially by America in 1891, and now more than half the total output of American coal is machine-cut. Only 8 per cent. of English coal is obtained in this way, although the method is more economical and safer for the miners. In the development of our gold mines in South Africa, the majority of the engineers were American and the machinery of American design. In smelting the same thing obtains. For many years this country held the premier position in copper smelting, and ore was imported in large bulk to Swansea and elsewhere for treatment. Gradually other countries began to break away and to establish their own plant. The English smelters pinned their faith to old methods and hard labour, and "best selected" was their standard. America, followed by other countries, developed

electrolytic refining, originally an English idea, and now quotations in "electrolytic" control the market. It is a ludicrous but painful fact that copper, smelted in this country, is sometimes sent to America for refinement and returned again here for sale. The U.S.A. now controls all its own copper, and is rapidly acquiring domination over the South American output. This will work a revolution in exchange, and lose to Great Britain one of the great advantages she has had in South American trade.

British smelters have required the mine owners to send the ore here at their own risk. America has fetched it, taking the risk themselves, and they are also establishing smelting works on the spot in South America.

In zinc smelting the story is the same. The industry originated in this country, but the local smelters have clung to small coal-fired hand furnaces, while the Germans, Belgians, and Americans have built large new furnaces with every fuel economy, and introduced hydraulic pressed retorts and scientific control of furnace temperatures. This has enabled them, even in a country with high wages, to meet a situation which British managers have confessed is too much for them.

In tin smelting a similar loss of position is taking place every day. We have lost our premier position in tinplate making, but hitherto, thanks to the authorities of the Straits Settlements, we have held that position in tin smelting proper. But our home plants, with one or two exceptions, are hopelessly old fashioned and uneconomical, and in consequence have to charge extravagant rates. Home mines are obliged to submit to these charges, but foreign mines will not.

Before the war the Germans were taking large consignments of ore from Bolivia, and had modern smelting works near Hamburg. On its outbreak Bolivian miners turned to England, but were treated so ungenerously that a large number of the more important companies, including some who had long sold here, contracted with the new and up-to-date plant near New York, where electrolytic refining can be applied to the smelting. The second largest mine in Bolivia is starting its own plant on the spot, and that will attract more ore from the South American mines. This state of affairs is most serious, and it is obviously due to the fact that the situation has not been scientifically handled, and that our existing plants are hopelessly out of date.

Some modern developments in Mining Machinery, and their country of origin:

Diamond drill	France, chiefly developed in America.
Percussive drill	do.
Hammer drill	do.
Rotating hand hammer drill	Germany.
Coal puncher	America.
Hurd bar machine	Great Britain.
Breast chain machine	America.
Continuous chain cutter	,,
Sikol coal cutter	Germany.
Disc machine	Scotland.
Skids	America.
Stamp mill	Gt. Britain, greatly developed by American engineers in South Africa.
The ball mill	America.
Conical tube mill	,,
Gyratory crusher	,,
Disc crusher	,,
Hancock jig	Australia, developed in America.
Acid-lined copper converter	Great Britain, developed in America.
Basic-lined converter	America.
Belt concentrator (Frue Vanner type)	,,
Table concentrator (Wilfley type)	,,
Rolls	Great Britain, developed in America.
Cyanide process	Scotland, greatly developed in America.
,, ,, vacuum filter	America.
Flotation process	Australia, now largely adopted in America.
Electrolytic refining	America.
Hydraulic pressed fetorts	,,
Scientific control of furnace temperatures	,,

§ 2 Well-Sinking and Tools

By H. H. Mogg, A.M.I.M.E.

During the past quarter of a century many improvements have been made in Well-Boring Tools and Machinery, the chief of which may be attributed to the United States, though Belgium and Germany have contributed largely.

The oldest form of boring is that known as the Chinese system. Strangely enough this system of boring has been reverted to by the Americans, but of course on modern and improved principles, and it is now generally known as the American Rope system of boring. In hard rock strata the appliances above mentioned would not be of any service; therefore another device, which the Americans claim as their system, is the "chilled shot" process of boring, now so much in vogue in Great Britain. This system calls for the use of a length of tube of thick steel, the tube being notched at its lowest extremity, and rotated upon the rock to be pierced. A small quantity of chilled steel shot is fed down the tube; this works under the lower end of the pipe by way of the notches, and the chilled shot rolls on the face of the rock under pressure. Water is continually being pumped down the boring which keeps the tube cool and removes the sediment coming from the rock. The solid core left in the boring is broken off at suitable intervals, and is then drawn up to the surface by means of a tube termed the "core-barrel." Some of these cores in large borings for water supplies are as much as 30 inches in diameter.

In some instances diamonds are substituted for chilled shot, the diamonds being mounted on a steel plate which is rotated at the bottom of the borehole, the head of the diamonds protruding beyond the surface of the plate so that they come in contact with the rock which has to be bored. Water is pumped through the boring to keep the boring head cool, as is done in the chilled shot process.

The United States are also the pioneers of the air-lift system of pumping. By means of compressed air, the water is driven to the surface. In this system of raising water all working parts are omitted from the well. This is a great advantage, particularly with the ordinary bore-hole pump, the moving

parts of which are sometimes several hundreds of feet below ground level.

Closely allied to boring operations comes the sinking of deep mining shafts and the sunk well. The German system of preventing large volumes of water from flooding the works is a substitution for the use of heavy and costly pumping appliances. In the process of boring large volumes of water burst from the sides of the well. These are frozen solid by means of freezing machinery on the surface. The water is thus held back until cast-iron cylinders can be fixed into the sides of the boring so as to effectively shut out the water impeding the progress of the work. This process has been used in Great Britain on several occasions with complete success.

The foregoing will serve to show how dependent we have been upon foreign countries for new ideas and developments in boring operations, sinking, and pumping appliances:

Chilled shot system	America.
Air-lift system	,,
Rope system	,,
System of freezing	Germany.

ELECTRICAL ENGINEERING

§ 1 Development of Electrical Industry in Great Britain

By E. P. Hollis

It cannot be said that Britain, the Motherland of such electrical geniuses as Kelvin, Swan, Faraday, and Thomson, has turned to full account the opportunities with which her electrical inventors have presented her. In electrical engineering, the well-known faculty of the British to be first with an idea, but backward with its development, has never appeared to better, or rather it should be said, worse purpose.

In practically every sphere, there is to be detected after the original experiments (which, we can now only too clearly see, threw wide open gates to a field of boundless opportunity) a failure to observe the value of what had been done, a chariness to pursue into the region of commercial practicability, and a disinclination to invest capital in setting on their feet

departments of the electrical industry, which, however speculative, were vital to British interests, not only as a well developed electrical country, but to our military and naval preparedness in particular.

To select instances involves an embarrassment of choice, and those taken, though typical, are only a mere fraction out of an enormous whole.

The incandescent carbon filament electric lamp had its origin mainly in Great Britain. It was developed from its primitive state by Swan, who had discovered the carbon, while Edison was still working upon the platinum filament. But the carbon filament lamp prospered commercially more in America than in Britain, and Edison's work laid the foundation for a big American lamp industry. Since then the carbon filament lamp research engineers and chemists, both in America and Germany, have sought after a filament of higher efficiency than carbon.

Success, however, first came to Germany with the pressed filament (one watt) tungsten lamp, but later America pushed ahead with the discovery of a drawn tungsten filament. As a result of the German and American discoveries, the two countries soon developed prosperous tungsten lamp industries—an industry which even now would scarcely have existed in Great Britain had it not been for the courage and foresight of Mr. Hugo Hirst in wringing from the German patent owners during the early days of the pressed filament, in spite of their strong disinclination, a licence to manufacture pressed filament lamps in this country.

The one watt tungsten lamp was followed by a successful outcome of exhaustive research work in America, where the gas-filled lamp was perfected (a big step forward), the ultimate development of which cannot even yet be foreseen. Already German and American engineers, chemists, and physicists, are seeking for further successes in the discovery of the luminous gas lamp, but in Great Britain, although we have the men, the organization is lacking, and we are still content to follow where we should lead.

The history of heavy electrical engineering in this country makes perhaps more comfortable reading than many other branches of the electrical industry; but when one contemplates the 30,000 k.w. steam sets now being manufactured in numbers in America and compares them with the kind of

machines at present running in this country, the outlook is far from reassuring. It is not that the British electrical manufacturer cannot make plant of this size; on the contrary, he can, if encouraged. Indeed perhaps the best insight into the situation can be gained from the fact that, when a Chicago power company required a huge set, bigger than had ever been made in America before, they came to this country, and obtained one which is giving thorough satisfaction. Contrast this attitude with that of the average British purchaser, who will not buy a piece of large electrical machinery, unless the manufacturer can show a number of sets of similar size running.

In rotary converters Britain has been particularly laggard, owing mainly to the neglect of heavy electric traction in this country. We can make big rotaries, but there is little call for them.

In high tension switchgear, Britain stands far behind America, Germany, France and Italy, owing in the main to our failure to develop high-tension long-distance transmission.

The development of electric traction in Great Britain, and on railways in particular, is one which makes very painful reading. So backward are we, that—to take one of a number of examples—the citizens of Birmingham, one of the largest cities in the British Empire, have never yet seen an electric train in their own town. Our failure to develop at home has reacted upon our abilities to obtain orders abroad, as our manufacturers have not had the experience which would encourage purchasers abroad to order traction material from us. Indeed the contracts for some of the heavy electrification projects in this country have gone to Germany and America. This is a cloud to which there appears to be no silver lining.

There was a time when, by all the signs and portents, Great Britain was to lead in electric vehicles, but a slump took place, and, except for a small fleet of buses in London, they were scarcely used commercially. A revival has set in, thanks to the hard work of a few enthusiasts, but the state of the development of the electrical vehicle industry in this country bears no comparison with that of the United States.

While colliery engineers in this country have, generally speaking, displayed a comparatively progressive attitude on

the question of colliery electrification, they have been very conservative in the matter of electric winding. Wedded to the steam winder from the engineering point of view, fearing to incur the heavier expenditure of the electrical plant on the financial side, colliery engineers have been slow to realize the advantages of electric winding.

In America and Germany more foresight has been displayed. Heavy electric winders in large numbers have been laid down, enabling the shaft output to be taken to a point far in excess of what would be possible by steam winding, and at a lower cost per ton. Our failure to develop our own colliery winding has contributed largely to the diversion of contracts for winding installations in various parts of our Empire (particularly in South Africa) into German and American hands.

In overhead transmission of electric power Britain is sadly behindhand. This country has no necessity perhaps for transmitting power at such high voltage as in America, but on the other hand, just as our lack of experience in electric traction precludes us from obtaining traction orders abroad, so does our lack of experience in overhead transmission similarly affect us. Even such a simple scheme as that of supplying London with electricity energy generated at the pit's mouth can make no progress. The vested interests against the proposal are too great. In consequence, quite apart from the important results likely to accrue to the electrical industry from the development of the use of electricity in London, a great opportunity is lost of showing foreign purchasers what our engineers can do.

No underground cables are superior to the British, our product being far ahead of either German or the American, as those who have laid down extensive systems on which comparisons can be made are well aware. Nevertheless, Italy seems to show a more technical enterprise than Britain.

British heating and cooking apparatus is no doubt the finest of its kind, and with few exceptions foreign apparatus is only sold in this country because of its cheapness. Unfortunately the domestic user often holds electricity to blame for any failures, and not the cheap foreign apparatus which he may happen to buy. Electrical heating and cooking have made small progress in this country compared with America. American power suppliers throw their utmost energies into the sale of power-using apparatus, and their advances are well

received by the domestic user. In consequence, American manufacturers are able to put their orders through in much larger quantities than our British manufacturers, with the result that a less expensive article can be produced.

Under this category come such articles as hair dyers, massage vibrators, vacuum cleaners, cigar lighters, sealing-wax heaters, and so forth, all of which are manufactured largely abroad.

Similarly, the application of electricity to refrigeration has been almost negligible in Britain as compared with America. Potential users have shown small enterprise and little inclination to adopt a plant which will pay for itself over and over again. Lack of education on these matters is to a great extent the cause.

To the electrical smelting of metals little attention has been paid in this country, mainly owing to our lack of cheap power. It has been felt that British smelting plants could not hope to compete with plants situated near the waterfalls of Norway and Sweden. This, however, has not prevented Germany and France from developing the manufacture of electrical furnaces. The result has been that a large amount of business in these furnaces is now in foreign hands. America too has paid very careful attention to these furnaces, and, while there have been one or two instances in this country where strenuous endeavours have been made to design and utilize electrical furnaces, progress in general has been comparatively small. The situation demands the co-operation of steel manufacturers, power suppliers, and of electrical manufacturers, capable of undertaking the construction of these furnaces, utilizing the energies of research engineers and chemists capable of designing furnaces suitable for meeting the requirements of our steel manufacturing processes. Sufficient experience is now available to enable many refining processes to be carried out economically by means of electricity, and it is well known that the extremely high class steel can be thus manufactured. In these refining processes electricity ought to make great headway in this country considering our large steel industry, but the smelting of iron ore is now, and must remain for some time, an economic, but of course not a technical impossibility.

Carbon-making for arc lamps, searchlights, and batteries, offers one, if not the most prominent, example, of the neglect

which this country has shown in electrical development. Until some years ago, the vast majority of carbons were imported into this country. As in the case of the metal filament lamp, Mr. Hugo Hirst set himself to put Britain on terms with foreign countries. A large factory was laid down at a heavy cost, which involved a loss of £70,000 in the first few years of working. Faced with heavy price reductions by foreign combines, and treated to an unlimited supply of cold water douches by private, municipal, and Government users of carbons, the factory has yet won through. To-day that factory is of paramount military and naval importance to this country and our Allies.

The writer is averse from throwing out destructive criticism unaccompanied by at least an equal amount of constructive matter. The question to be answered is: What is at the bottom of our electrical backwardness? To prescribe the remedy without ascertaining the cause would be mere quackery.

In the writer's opinion, the underlying reason of our backwardness is this. The development of a new industry, like the electrical industry—for it is new compared with others in an old industrial country like ours, in which old ideas are rooted by reason of the very antiquity of our engineering trade—cannot be left to a haphazard development. There must be some organization with a heavy driving force behind it. It is no doubt easy enough to blame Governments as the source of all evil. Nevertheless it can hardly be denied that successive British Governments, with ideas incapable of soaring above forensic matters, have by their legislation time after time crippled the electrical industry, particularly by their Electric Lighting Acts.

There have been grave sins of commission. What of those of omission? These have been of even greater enormity. It is difficult to point out a single instance of any branch of government, except that of the Board of Trade in its recommendation of electricity instead of gas on trains, encouraging the development of electricity. Suggestions of big power schemes for example have been opposed by the Government, and the fullest measure of discouragement given on every possible occasion.

Of the many things that require to be done to set matters right, the following are a few:—

(*a*) The immediate appointment of an Electrical Power Commission with full powers to organize and assist financially the supply of cheap electrical power to London and other large towns. It must have power to crush vested interests opposed to electrical progress. The Ontario Power Commission affords an example of what can be done in this direction.

(*b*) An immediate investigation, technical and commercial, into the problem of low temperature distillation, with the object of ascertaining what products can be drawn from coal, and how electricity can be generated thereby, and not as a main but as a by-product.

(*c*) An immediate inquiry into the problem of electrifying our suburban and some main railway lines, together with the adoption of some system which shall be standard for all or nearly all lines. (The use of different systems of electrification ought to be as much tabooed as the use of different gauges.)

(*d*) The inauguration of an extensive and efficient propaganda by a competent electrical authority (Institution of Electrical Engineers, or British Electrical and Allied Manufacturers' Association) amongst householders, manufacturers, colliery engineers, steelworkers' engineers, and other potential users of electricity.

(*e*) Direct Government assistance in the nurturing of any new development of the electrical industry, such as steel refining.

(*f*) An immediate inquiry by the Admiralty into the question of marine propulsion by electricity, both as applied to the mercantile marine and the navy.

(*g*) The immediate organization of a national research laboratory capable of tackling large electrical manufacturing problems, and not mere physical investigations.

The above suggestions deal with a few of the things requiring reform. But what is to be done ought to be done quickly! War will follow war. A trade war will follow a military war, and our unpreparedness for the former in 1916 is not less than it was for the latter in 1914.

A short list is appended, giving particulars of various branches of the electrical industry, and indicating in what country the greatest developments have occurred :—

Turbo-alternators	America.
Overhead transmission	„
Underground transmission ..	Great Britain.
Rotary converters	America.
Transformers	„
Electric traction	America and Germany.
Incandescent lamps	America, Germany, and Holland.
Arc lamps	Great Britain.
Small motors	America.
Continuous current generators ..	Great Britain.
Electrical marine propulsion ..	America.
Electric vehicles	„
Heating and cooking	„
Primary batteries..	„
Lead secondary batteries ..	Great Britain.
Alkaline „ „ ..	America.

§ 2 Electrical Fittings

THIS generic term covers various appliances which, before discussion becomes possible, call for classification thus:

(*a*) Fittings of high æsthetic quality for the electric lighting of large and important buildings, country mansions, etc.

(*b*) Fittings of good appearance for domestic purposes.

(*c*) Fittings of strictly utilitarian nature.

(*d*) Fittings possessed of highly efficient illuminating qualities.

(*a*) The degree of excellence attained in the manufacture of fittings of high æsthetic quality depends less upon the state of the electrical development of a country than upon the craftsmanship at the manufacturer's disposal for the design and manufacture of works of art. Naturally, each country has its own school of design, and in no other country than in England are more beautiful fittings manufactured.

Fittings of ecclesiastical design and of fine appearance are manufactured in considerable quantities in Germany, but, to the English eye at any rate, nothing is more pleasant than electroliers and other similar fittings of English design. British manufactuers hold their own well for goods of this class.

(*b*) Fittings of a less intricate nature for domestic purposes are manufactured better in this country, and, quality for quality, are cheaper than similar fittings from elsewhere. But Americans have put on the market articles which have met with considerable success, because they have been designed by electrical engineers for electrical purposes, and are not a development of something originally intended for gas or candle lighting. They are constructed for easy wiring, for variation of the number of lighting units without altering the standard design, and have a generally attractive appearance, without being out of place in a tastefully decorated room or office. Many of these American fittings are possessed of the high illuminating qualities mentioned under heading (*d*).

(*c*) Germany has seized a large proportion of the world's markets for cheap fittings. Her manufacturers had attained cheapness by lightening the articles all round, and they turned out, at any rate for some time after their installation, devices well adapted for accomplishing this purpose. The prices were astoundingly low. Tumbler switches, lamp holders, ceiling roses, fuse carriers, and so forth, were manufactured in such huge quantities, and at such low cost, that it was difficult to compete with them on a basic price. Germans all over the world were made certain of the business in these goods by methods of which the following is typical:—

In a certain South American country, Germany had obtained a control of the electrical supply companies, and these firms, in addition to installing German electrical plant in their power houses, refused to connect apparatus to their system unless it complied fully with their requirements. These requirements were so framed that the purchaser was compelled to buy a certain make of fuses, switches, and the like, which were exclusively of German origin.

(*d*) In the earlier days of electric lighting, British engineers, foremost amongst whom was A. P. Trotter, realized the necessity for the use of proper apparatus for the distribution of light from a source of illumination. That work has borne good fruit—but in America, not in England. America now stands pre-eminent in what is termed illuminating engineering, and in the manufacture of apparatus for assuring the correct distribution of light from a source. In that country, the study of illumination has made great headway, and the results are widely applied. In this country, the circle in which

a study of illuminating engineering has been made is a very narrow one, and the prejudices against efficient methods of lighting are very hard to overcome. An Illuminating Engineering Society has been inaugurated in this country, and has done most excellent work in spreading illuminating engineering knowledge amongst the men, on whom falls the responsibility for lighting buildings. But there is no sign that the successful lead taken by America will ever be challenged. A huge business is now being done in that country in devices for efficient illumination, such as shades, indirect lighting fittings, and the like, while there is a large home (American) market for electrical apparatus of this description. English manufacturers have not the same home market, because the failure to appreciate the value of good lighting restricts the demand, and damps the initiative of British manufacturers (actual or potential) of this class of articles. Recently, British shopkeepers in London and in the large towns have utilized considerably the efficient illuminating devices offered, but in the small towns, and in the large towns outside the shipping centres, the average shopkeeper does not aspire to good window dressing, and the shop lighting is in keeping with that dressing.

Aesthetic fittings	Various.
Domestic ,, ...	America.
Standardized miscellaneous fittings	Germany.
Illuminating engineering..	America.

§ 3 Electrical Industrial Research in Great Britain

On the degree of the excellence of its research-organization depends to a large extent the success of a country's industries. America and Germany have for a long time paid the greatest possible attention to research work. They have realized that the manufacturer's success is dependent upon research success, and in these countries research is conducted, not as in England as a matter of academic importance, but as one of absolute commercial necessity. In England, money is put into research as if it were a charity; in Germany and America, the electrical manufacturer spends his money on research in order to secure bigger dividends.

Throughout the British electrical industry there has not been the slightest sign of industrial electrical research being carried out on a co-ordinated or organized basis as in other countries. The National Physical Laboratory is the largest institution concerned with research, and it undertakes investigations on certain matters, accomplishing good results as far as they go, but its investigations incline more towards physical than towards industrial matters.

The Institution of Electrical Engineers prides itself on its aloofness from industry, and on occasion applies itself to some technical question of interest, but never on any other but an "arm-chair" basis. It has no research laboratory of its own wherein it can make any investigations, nor has it in any part of the country amongst its members a single one possessing a research laboratory wherein electrical industrial investigations can be resolutely tackled.

Our universities and university colleges contain material which, if properly applied to electrical problems, would be a powerful asset to our industries, but they work, in a majority of cases, on problems often of no great industrial interest, with no co-ordination, and with no relation whatever to the requirements of the factories. During the war the value of these men has been realized and they have been utilized on important munition problems. They have achieved successes, the importance of which is only realized by those who are best qualified to judge. That they should be utilized in war time and not in peace time is a grievous fault, and one which is likely to recur, unless some capable guiding hand institutes an organization to direct this material to its proper function in industrial research.

Germany more than other countries had its engineering organization developed to the fullest possible measure as an instrument for commercial use. There were no unbridgeable gaps as in this country between the scientist and the factory. The scientist worked with the factory, for the factory, and was paid by the factory. The universities applied themselves to the production of a class of men who were capable of undertaking research work for commercial purposes.

The research engineer in Germany was part and parcel of the industrial machine, without whom it would not work, and it was realized that on him depended to a large extent the success or failure of attempts to develop industry. Moreover,

when the universities had trained the men, they knew that there was no lack of employment for them.

Amongst the electrical problems that German engineers had undertaken were such investigations as the invention of the tungsten lamp filament, and their discovery of the pressed tungsten filament was one of revolutionary importance to the electrical world as a whole, and contributed largely to Germany's electrical success. America, in July, 1914, stood ahead of Germany in tungsten lamp manufacture as a result of the latter American discovery of the drawn tungsten filament. This discovery was not a fortuitous occurrence, or a lucky hit, while experiments were being carried on with a different purpose in view. It was the result of a solid co-ordinated research work by a body of experimentalists forming part of one complete organization.

Popular literature often delights in recording trivial incidents held to be the origin of important inventions. Such things do not occur in electrical engineering. Epoch-making inventions in electrical engineering come only after years of organized research. They are the fruit of careful cultivation and not of wild growth.

Even at this moment when these things are understood in Great Britain as they never were before, there are no signs in British electrical engineering of any authoritatively formulated scheme of organized research. There is not even a scheme of co-operative research amongst manufacturers, and no authority to whom the results of research may be communicated. If an investigator after laborious experiments fails in his object, his failure is never disclosed, and other investigators travel by the same path into the same cul-de-sac, simply because there is no organization to enable investigators to profit by the failures of those who have gone before them.

It is not to be gainsaid that the outlook for progress in British electrical engineering is bad. With an Institution of Electrical Engineers whose attitude towards progress is—to use the most charitable word—listless, such an industry as electrical engineering, which has never commanded Government support or sympathy, can only be saved by some revolutionary change.

But whence this change is to come is not apparent. The only hope seems to lie with the British and Allied Manufacturers' Association—a powerful body imbued with the spirit of

progress, and controlled by men whose attitude inclines as far towards progress as does that of the Council of the Institution of Electrical Engineers towards reaction.

Research work	America and Germany.
Organization	Germany.
Tungsten lamp filament	"
Drawn tungsten filament ..	America.

§ 4 Wireless Telegraphy

WHILST much credit has been attributed to Marconi as being the inventor of wireless telegraphy, it would appear upon investigation that his "discoveries" were more in the nature of developments than original ideas. The conception of the existence of electric waves was worked out by an Englishman —Professor Clerk-Maxwell, of Cambridge—ten years before Marconi was born. Professor Clerk-Maxwell did not prove experimentally the existence of such waves—that was left to Heinrich Hertz, a German professor at Karlsruhe. The ball-oscillator which made it possible to send out waves of great power—eventually to bridge the Atlantic—was the result of an idea which came to Professor Righi, an Italian, of Genoa.

The delicate "coherer," which first made wireless telegraphy possible, was the invention of a Frenchman, Professor Edouard Branly: the "decoherer" is rightly credited to Sir Oliver Lodge. This latter invention was the first instrument which suggested that ordinary Morse letters could be registered with the Hertz waves. It is difficult to determine definitely as to who was the first to conceive the idea of utilizing the Hertz waves for wireless telegraphy, as it sems to have come independently at about the same time to several minds—notably amongst which being Sir Oliver Lodge, and a Hindoo, Professor Jagadis Chunder Bose, of Calcutta, Marconi and Popoff in Russia.

The origination of the idea of "syntony," *i.e.*, tuning two instruments to act in unison, which, if it can be attained, would ensure secrecy, and result in several messages being received at the same station simultaneously, was chiefly due to Sir Oliver Lodge. It should be noted that in the experiments made by the foregoing, they employed the induction currents discovered by Michael Faraday. Additional investigators may

here be mentioned, *i.e.*, Poincaré, and Turpain, of Paris; and on the more practical side, Lieutenant Tissot, of Brest. The Marconi is but one of a number of wireless telegraphy systems; for instance, there are two from Russia, two or more from Germany, one from France, one from Spain, and several from England. It must not be lost sight of, however, that it was Marconi who did the practical things, and after repeated experiments he was successful in sending messages, first of all from one mile, then from twenty miles, followed by nearly two hundred miles, and lastly across the Atlantic ocean. One of the outstanding features of the inventions in connection with wireless telegraphy, and one which is well worthy of note, is that wireless telegraphy has been made possible by men who do not take out patents and whose work is not done for money.

Existence of electric waves	Great Britain.
,, ,, ,, demonstrated	
Hertzian waves	Germany.
Ball-oscillator	Italy.
Coherer	France.
Decoherer	Great Britain.
Utilization of Hertz waves for wireless telegraphy	Great Britain, India, Italy, Russia.
Syntony	Great Britain.
Induction currents	,,
General developments	Great Britain, France, Italy, Russia.

TRAVEL

§ 1 Automobiles

By Henry Sturmey

The whole of the marvellous development of the motor-car and the now huge motor industry which it supports has grown from nothing within the past twenty-five years, and is a striking example of the need for a sounder education, not so much as regards our engineers as our business men, working men, manufacturers, politicians, and capitalists. But for the short-sighted legislation of the early part of the last century, not only would the world have had the advantage of the

mechanically propelled vehicle a generation earlier than it did, but this country would have occupied an unassailable position in that industry, for there were many quite successful steam carriages built by English engineers fifty or sixty years ago; but the legislative requirement of the red flag—brought about by prejudice and the opposition of horse interests—killed all further development other than the traction engine, in which British producers are to-day supreme.

The same legislation kept British engineers out of the newer development until 1896, by which time the motor-car, driven by an internal combustion engine, after its invention in Germany, had been already developed into a small but thriving and exceedingly prosperous industry in France. Entering late into the field, on the removal of the legislative restrictions, prejudice and conservatism of ideas prevented the new industry receiving any support from either our large engineers or our large capitalists for many years, and it was left to amateur enthusiasts and comparatively small constructors and investors to develop. At that time, undoubtedly, the influence of scientific education was badly needed. The possession of a Whitworth Scholarship in engineering, for instance, was found by one young man of my acquaintance a bar rather than a help to advancement, or even to getting a post at all! This view of things has, however, long been altered, and our leading firms now have their properly equipped laboratories and staffs of qualified engineers. Government still does little or nothing to help the industry, but, by treating the motor-car owner only as a milch cow to be "milked" till dry, financially, is doing much to hinder further expansion in this country, whilst Capital still holds aloof from giving the industry that whole-hearted and adequate support, without which no great expansion can take place and with which America is making such wonderful strides.

In spite of these handicaps, the British motor industry has now for some years occupied a position of supremacy in Europe, having surpassed its forerunners, both France and Germany, particularly in regard to motor-cycles and motor-wagons, *i.e.*, commercial vehicles, in both of which branches of the industry British machines are supreme. Indeed where quality is concerned, no country in the world surpasses the British production in any branch of the automobile field.

But the trade of the world is not to be done in the highest

class machines, and where volume of production and low price are concerned, particularly in the four-passenger car, it is very largely in the hands of America. This is due to environment, the more rapid appreciation of new developments by the American people, and more particularly to the whole-hearted support of the American capitalist, who is quick to see the possibilities of new inventions, and puts big money into new developments, knowing that low price can be obtained by standardized quantity production and that an attractive price will secure sales; whereas the attitude of mind of the British capitalist is still that of the Mayor of Coventry some fifteen years ago, who plaintively exclaimed, when asked to favour the formation of a new motor company in the City, "Motor-cars! motor-cars!! Will you *ever* sell any if you make them?" The British capitalist, looking for a "get-rich-quick" proposition, will support any "boom" that may be going, but will only support manufacture if demand be first created. The American is educated to see that successful manufacture in itself creates demand, and, protected in his own market, which is the largest and most receptive in the world, the American producer has, in the construction of motor-cars, developed methods of production which are the wonder of the world, the latest manufacturing development being the moving platform system of assembly, by which a car is completely assembled from its components, including the fitting and painting of the body, in less than half a working day, and, whilst the entire production of so-called "pleasure" cars in Europe does not reach 100,000 per annum of all types, one firm alone in the States will produce this year close on 500,000 of a single model, whilst half a dozen others will each individually produce more than the collective production of Great Britain which is itself the largest in Europe! Productive methods which it is not possible for European small-quantity producers to employ, are rendered possible by the large production, and although labour is paid from two to three times what is paid here, the goods cost less to produce, for reproductive supremacy is assisted by the workman, whose education teaches him that Capital is the friend and not the enemy of Labour, and that the suicidal restriction-of-output methods of our Trade Unions, with which industry is hampered here, are economically unsound.

So far as the export trade is concerned, if we leave out the

American cars whose export is probably four to five times that of Europe combined, British manufacturers to-day occupy the foremost position in comparison with their European competitors, in spite of the handicap of inadequate banking facilities, for the motor industry—or any other, for the matter of that—receives no assistance from British banks, which require as much education in the requirements of the times as any other class of the community.

Many of the leading constructional features of present-day automobiles have been originated in this country, but from causes above indicated, their commercial success has in many cases been due to other nations, and the motor-car of to-day is a very cosmopolitan production, as the following will show :—

The internal combustion engine, using petroleum spirit, originated in Germany, but has met with much larger development in other countries.

The float-feed carburettor, now universal, is of German origin.

Magneto ignition was first introduced in England, but lack of financial and manufacturing support threw the trade into German hands, which, before the war, held a practical monopoly in Europe.

Gilled tube radiators originated in France, but the honeycomb or cellular radiator, carried in front of the engine, which position is universal to-day, is a German invention.

Friction clutch engagement of engine with transmission and control by pedal, now universal, is a French invention.

The sliding gear, now also universal with variations, is also French.

The present general design of cars with engine in front and with pedal and hand control is French.

Final drive by pitch chains from a differential countershaft to a solid "dead" axle, which is still used on heavy motor trucks, is the original German system.

Shaft transmission with "live" axle is more British than French, though each of these countries developed it simultaneously.

Worm drive, instead of bevel as final transmission, is British, both in origination and in principal adoption and successful development.

"Gate change" of gear lever arrangement, with selective

transmission, now practically universal, though first invented in England, owes its present form and popularity to Germany.

The Thermo-Syphon system of cooling by natural convection was first applied by a British firm.

Wheel steering, with irreversible worm and sector transmission, originated in France, as the outcome of the early road racing.

The Akerman system of connecting the steering wheel is an adaptation of a British system, before used on double steering tricycles and on some of the early steam road carriages.

Throttle control of engine speed is of American parentage, but owes its commercial development to France.

Pressed steel chassis frames are a French development.

The adoption of the artillery wheel is likewise French.

The pneumatic tyre is a development from the bicycle tyre, an Irish invention, but its successful application to motor-cars is due to France.

Detachable rims originated in America, but owe their commercial development to France, although to-day more largely used in America.

Detachable wire wheels are solely British, both in origination and development.

Cantilever springs are a purely British development.

Metal panel bodies and wings originated in France, using aluminium, and have been brought to commercial perfection in America with steel.

Acetylene lighting sets and head lamps owe both their origin and chief development to France.

Electric lighting is American.

Engine-starting by electric, pneumatic, or mechanical means, is American, both in inception and development.

The speedometer and distance recorder, originally British, has been developed to its present perfection in America.

The bulb horn is French, an adaptation of an instrument previously used on horse omnibuses, but the electric and mechanical horn, as well as the exhaust-operated horn, are American, both in inception and development.

The so-called "Cape-cart" hood is of French origin, adapted basal idea from the Cape-cart.

Taximeters are a French adaptation of an instrument previously used in that country on horsed cabs, and their manufacture has been largely monopolized by Germany.

The steam car, or, more particularly, the steam wagon, is essentially British.

The electric carriage was first introduced in this country, but owes its present development almost entirely to America.

The first application of an I.C. engine to a bicycle was made by a German.

The air-cooled bicycle engine is French, and the most successful motor-bicycle as well, but the present form of motor-cycle and its development to perfection is essentially British.

Variable gears for motor-cycles are British—a development of the variable gear for pedal cycles, also British.

The kick-starter is British also.

The first application of the I.C. engine to road carriages other than bicycles, was made in Germany, but the credit of its popularity and development to present form is due to France.

The application of the I.C. engine to commercial vehicles also originated in Germany, but its great and successful development in this form is British.

Cycle-cars were originally British, but failed through lack of financial and manufacturing support. They were re-introduced in France and again taken up and brought to maturity here, whilst the light car, as a development from them, is entirely British, and the British product is supreme.

Though the first applications of an I.C. engine to aeroplanes was American, to France belongs the credit of the development and perfection of this form of motoring, whilst to France is due the application of motor power to balloons, which were thus for the first time made navigable, and the development to perfection of this type of aircraft rests with Germany, which country at present almost monopolizes its manufacture.

To Germany belongs the credit of origination of the motor-launch, in which branch of the motor industry, however, she is now exceeded by both Great Britain and America, the former holding supremacy in quality productions, and the latter, as in automobiles, in the smaller cheaper varieties, whilst to Sweden belongs the credit of supremacy in the motor-ship, vessels of upwards of 10,000 tons being now motor-propelled, and it will not be many years before we have the motor-battleship.

In standardization and concentration of production upon a single model, America is king, and the marvellous development of special machine tools for automobile quantity production and labour-saving methods are American alone.

Internal combustion engine	Germany.
Float feed carburettor	"
Magneto ignition	Great Britain and Germany.
Radiators	France and Germany.
Friction clutch	France.
Sliding gear	"
Present general design	"
Chain drive	Germany.
Live axle transmission	Great Britain and France.
Worm drive	Great Britain.
Gate change	Great Britain and Germany.
Thermo-Syphon cooling	Great Britain.
Wheel steering	France.
Akerman system	Great Britain.
Throttle control	America and France.
Pressed steel chassis	France.
Artillery wheel	"
Pneumatic tyre	Ireland and France.
Detachable rims	America and France.
Detachable wire wheels	Great Britain.
Cantilever springs	"
Metal panel bodies	France and America.
" " wings	" "
Electric lighting	America.
Self-starters	"
Speedometers	Great Britain and America.
Horns	France and America.
"Cape-cart" hood	France.
Taximeters	France and Germany.
Electric carriage	Great Britain and America.
Steam wagon	Great Britain.

§ 2 Railways

EVERY penny raised by British Railway Companies has to be sanctioned by Parliament, and with the rise in the cost of working which has taken place in recent years, largely owing to causes outside administrative or executive control, Directors have been cautious in incurring capital outlay, especially where the dividend-earning results were of a speculative character. Then too the Board of Trade has exercised a far greater control in all matters where the safety of passengers and employees is concerned than the Railways of the United States have been subject to, and this has tended to restrict the introduction of

new inventions, the exact results of which could not be foreseen. It is not surprising therefore that in some directions American Railway management has been first in the field with improved methods of working, and that British Railway officials have waited for fully ascertained results before adopting these improvements. It is however only right to record that in many directions British Railway enterprise has been first in the field.

Underground Railways.—The Metropolitan Railway, opened in 1863, was the first of its kind.

Tubes.—The City and South London Railway opened in 1890, constructed under the Greathead Shield System of the late Mr. Greathead, a British engineer, was the first of its kind, and the subsequent developments of the system of construction have given London, with the two other Underground lines, the finest network of sub-surface transport in the world. American capitalists helped in bringing the system to its present standard, and some American inventions have been used in securing wonderfully efficient services as well as the public safety.

The lifts used on the underground railways are of American design, as are also the moving stairways now taking the place of lifts to some extent.

Overhead Lines.—Such a line as the New York Overhead Railway, the first of its kind traversing important thoroughfares, would not be tolerated in any city in this country. The Liverpool Overhead Railway, opened in 1893, is the only line of the class in England. As it mainly serves the Docks, it is not open to the objections which the British public would entertain to the running of such routes through residential streets.

Electric Railways.—In the introduction of electric working, the United States can claim pre-eminence, and Italy and Germany have also done valuable pioneer work in this direction. British Railway officials are greatly indebted to the experience gained in these countries for methods of working electrically.

The Electric Traction Industry (Tramways).—Although some of the very earliest tramways are to be found in Great Britain, the real growth of electric traction is due to the pushfulness of the United States of America, closely followed by Germany. The first commercial electric tramways were opened for traffic in this country in 1905, and the market was immediately

flooded with American motors, trucks, and even American carriage bodies. The special insulation in connection with overhead wires also came from America.

Railway Electrification.—We have followed America and Germany's lead, and the majority of the motors and electric equipments for our electrified railways have come from the United States, whilst a portion has been supplied by Germany. Generally speaking, as regards the electric industry, it may be stated that it has drawn a large portion, if not the majority, of its supplies from the United States and Germany.

Light Railways.—State and county aid has been withheld, except in Ireland and some few instances in Great Britain, from the encouragement of the construction of light railways in agricultural districts, where the prospects of traffic would not justify the outlay of private capital. In Belgium notably, the State has provided this class of transport to the great benefit of the community. If the State were to work in co-operation with existing companies, valuable assistance could be given to agriculture and other industries, if the comparatively small amounts required for securing a return on capital invested were forthcoming.

Dining and Sleeping Cars.—The long runs by trains in the United States called at an early date for this class of accommodation for passengers, and British Railway officials were indebted to American experience, when these cars and carriages were introduced into this country. Subsequent development has however been purely British, and few specially American features now remain.

Corridor Carriages.—The idea of the intercommunication of the whole train was American in origin. The system was introduced there to meet the requirements of very long runs. The Corridor-plan, which we have on our British Railways, was an adaptation of the American idea. It combines the privacy (so dear to the British traveller) of a single compartment with the advantage of semi-publicity.

The Baggage Check System.—In America and on the Continent, this system has long been in use, but in this country the public has become accustomed to the "scramble" method, and whilst the latter is recognized as altogether wrong in principle, the rapidity of its operation, with the marvellously small loss of luggage involved, reconciles most travellers to its obvious disadvantages. If there were any strong wide-

spread demand for the check system, it would be adopted by the companies.

Track Layers.—These are mainly useful for pioneer lines across prairies, and for other similar conditions. They are used, to some extent, in British Colonies.

Rail Motor Cars.—These are essentially British in idea. Many authorities now consider old engines, or light new ones, more useful on the whole. On the Continent and in America, such cars are largely of special types suited for long country sections with little traffic.

Bogie Suspension.—The Bogie system was a necessity for the big cars and rough character of the early American lines. Here and in Europe it has followed the natural course of evolution. As long ago as the 'seventies the British "Fairlie" bogie engines attracted attention.

All-steel Wagon and Carriages.—Under this head America took the lead, to some extent for constructional reasons, in connection with the very large cars in use. Authorities in this country are not all in favour of the all-steel system for British conditions. The very-high-capacity wagons in use in the United States are not required for general English traffic.

Power Signalling.—In this connection we are undoubtedly behindhand, and it is mainly due to the United States that we are indebted for the development of practical apparatus as used on the London Underground Railways, and at certain large stations such as Newcastle Central, Glasgow Central, Bolton, etc. There are moreover a number of isolated signals, or groups, on particular sections of line, and some intermediate signals, where it is desired to break up long signalling sections without installing additional signal cabins. But even where apparatus of American origin is used, a good deal of original work has been done by British engineers, and some features may even be considered as exclusively British.

The principal explanation of the situation is that America provided a field for power signalling, and the way was largely clear for working in this direction. Here we already had a very complete equipment of manual signalling, so that it was only where special opportunity arose, as in connection with the electrification of the London Underground lines, and the construction of the newer tubes, that such plant could be installed, while in other instances the re-modelling of stations enabled new plant to be put in. When such opportunities have

arisen they have usually been taken advantage of; but the wider scope afforded by the relatively clear American field was necessary to allow of the required experimental work to be undertaken.

In Europe, there are a number of instances of the employment of power, and of automatic or semi-automatic equipment; but these have usually been installed to meet particular conditions. As regards German ideas, we have only a few Siemens-power plants, and even for these the working out has been largely done by the British staff, though based upon apparatus already employed in Germany.

Continuous Brakes.—The Westinghouse brake is American; the Vacuum system is British.

§ 3 Locomotive Engineering

By J. F. Cairns

A few features may be broadly analysed.

Superheaters.—The usual type of apparatus in use was French in origin. It was partly due however to British engineers that the well-known Schmidt system obtained support. Unfortunately, the firm concerned failed, and before much further could be done the Prussian State Railway officials took the matter up, with the result that German influence became pre-eminent. Subsequent development has really been international, and the modern apparatus is due to the combined work of British, American, Belgian, French, and other engineers, as well as those in Germany, though the German firm, which dealt with the whole of Europe except the United Kingdom, necessarily became the controlling factor, with the British and American firms second in importance. In due course, we produced the "Robinson" apparatus, which is wholly British, and is attaining very wide use, particularly where British methods and influences prevail.

In America, though essentials are the same, the methods employed are different. It is mainly on account of the great dimensional freedom, the peculiar conditions and demands, and the possibilities offered thereby, that locomotive engineering in America (including Canada) has developed to so remarkable a degree. But, admitting all this, it is extremely doubtful whether many features of American practice would commend

themselves in this country. Besides which, some European designs include similar characteristics, and in building for abroad we have, when occasion required, developed on somewhat the same lines. Moreover, American firms build, when required, to European designs, and both Continental and British firms have constructed many engines, which have included American features.

There are indeed often as great differences between the methods of one English railway and those of another as between British, French, German, Italian, Austrian, and Belgian characteristic practices. American practice on the other hand is mainly of local development, and is largely due to the conditions and requirements applicable there.

Boilers.—(1) Ordinary round-topped firebox type; widely used in the United Kingdom, Germany, and other parts of Europe, the British Colonies, South America, etc.

(2) Belpaire type, of Belgian origin; extensively used in England, France, South America, the British Colonies, and other countries.

(3) Wide type; now charactistic of American practice, also found in numerous Continental designs. With our high grade fuel, there appears little need for this type in England, though it is used on two British railways.

(4) Taper-ring Boilers; a frequent feature of American practice; now included in some British and a number of Continental designs, but rarely so as to be suggestive of its American origin.

Cylinders, Motion and Valve Gear.—Differences mainly relate to variations of practice, and scale of design. The Walschaert gear, of Belgian origin, is now being used all over the world, and especially in America, as it meets the conditions which now apply better than certain other gears. Previously, it was essentially Continental in use.

Compounding.—We were involved in the earlier developments, but at a later period the practice was transferred to the Continent. For articulated designs it is still being used in the United States, but is virtually dead for ordinary types.

Three and Four-Cylinder Simple Practice.—We have done most with these, but Europe has followed our lead to some extent, and America has done a little.

Oil Fuel.—Developed in American and European States where convenient oil supplies are available.

Tank Engine Development.—Mainly characteristic of British practice, but a good deal has also been done in Europe.

For large articulated and special designs, America has taken the lead; but there is little scope for similar practice anywhere else, and engineers have usually adopted their own methods. The Mallet type, now so favoured in America, is of French origin. It is also used by Continental firms, and we have built a number of engines. The Fairlie type has always been characteristically British. The Kitson-Meyer and Garratt types are essentially British.

Underground railways	Great Britain.
Tubes	America.
Lifts	,,
Overhead railways	,,
Electric railways	,,
Electric tramways	America and Germany.
Light railways	Belgium.
Dining cars	America.
Sleeping cars	,,
Corridor carriages	,,
Baggage check system	,,
Power signalling	,,
Track layers	,,
Rail motor-cars	Great Britain.
Bogie suspension	America.
Steel carriages	,,
Steel wagons	,,
Superheating	Great Britain and Germany.
Continuous brakes	America and Great Britain.
Boilers (various types)	General.
Cylinders	Belgium.
Motion gear	,,
Valve gear	,,
Compounding	General.
Three and four cylinder practice	Great Britain.
Oil fuel	General.
Tank engine development	America, Great Britain and France.

§ 4 Flying Machines

THE art of ballooning was not discovered until the eighteenth century, but, previous to this, many attempts, some of which were said to have been successful, had been made to fly by

imitating birds. Thus the origin of the aeroplane dates back before that of the dirigible, although the latter was, until recent years, the more familiar type of the two.

Considering first the development of the aeroplane within recent years, the most epoch-making step was taken by Otto Lillienthal in Germany in 1891, who discarded the old idea of flapping wings, and started a series of gliding experiments with a specially constructed apparatus of his own design. He had examined the shape and resistance of birds' wings in motion through the air, and had found the great advantage of the cambered over the flat plane. His first apparatus consisted of a pair of rigid outstretched wings, formed by cambered planes of cotton fabric over a willow framework, and varnished with a preparation of wax. He found the fluctuation of the wind so disturbing that he decided to fit a tail to his glider. He supported himself between the wings, and prevented himself from capsizing by throwing out his legs forwards, backwards, or sideways. In 1894 he made an entirely new type of machine, a biplane. In 1896 he made a light machine, and fitted it with a 2½ h.p. motor. He met his death during a gliding experiment the same year.

Many other attempts were made about the same time, both in this country and abroad, with varying success; notably that of Sir Hiram Maxim and Pilcher in this country, and Professor Langley and Mr. Chanute in America. What is perhaps the most important work of all falls now to be chronicled, viz., that of Wilbur and Orville Wright in America. At the time of Lillienthal's death, they had fully recognized the enormous advantages of gliding as a means of obtaining effective experience with the minimum of trouble and expense. Before getting out designs, they took into consideration the features of the Lillienthal, the Pilcher, and the Chanute machines. The result was that they evolved a type of their own that embodied from the first new characteristics.

Their experiments started in 1900. Their most successful machine was a double-decker with a hinged horizontal rudder in front. Steering to the right or left was effected by warping the wings. It was afterwards found useful to add a vertical rudder to assist in steering. The apparatus could be controlled so well that the Wrights thought it safe to pass to the construction of a flying machine equipped with a propeller and motor. The first flight took place in December, 1903. In the

summer of 1908 Wilbur Wright went to France, and in September of that year he remained in the air for over 1½ hours, and covered a distance of nearly sixty-one miles. He also flew with a passenger on several occasions. The Wrights were the first to introduce the now almost universal method of steering by the use of a vertical rudder, and warping the wings.

About the time of the Wrights' success other experimenters were also busy in their own way. The most important of these were the Voisin Brothers, Mr. Henry Farman, and M. Delagrange in France.

In 1909 the science of aviation made great strides. In February Mr. S. F. Cody at Aldershot flew 400 yards in a machine of his own construction. On July 25th Louis Bleriot flew the Channel. After this the science of aviation progressed rapidly both in this country and abroad. In 1912 our Government decided to develop aviation as a new arm of national defence, and decided on a competition to ascertain the best type of machine. The events were thrown open to the world; seventeen British and French machines took part. The first prize went to the Cody machine, and the second to the French Depurdussin.

Modern aeroplanes are divided into two main types, the Monoplane and the Biplane. The Monoplane is built for high speeds and light weight, and has thus small supporting surfaces. The Biplane is built for lower cruising speeds, and for weight carrying.

A new type of aeroplane was produced about 1911, known as the seaplane. It has floats attached to its under parts, by virtue of which it can float on the surface of the water, and can rise into the air from it and alight upon it again. The first success with these was in 1911 by Mr. Glen Curtiss, of America. The success achieved at home and abroad with these machines led to the formation of the Naval Aviation bases round our coast.

It was the invention of the fast running internal combustion engine, giving a large power for a small weight, that made mechanical flying possible. The first successful engines for this purpose were produced in France. The first British-built engine to meet with any success was the Green engine.

Dealing now with Dirigibles, the first that gave any prospect of success appeared about 1884, when the Tissandier Bros., of

France, experimented with an airship propelled by screws driven from an electric battery. In the same year Captains Renard and Krebs, of France, made similar experiments on behalf of their Government. The next great step in advance was made by Santos Dumont, a Brazilian, residing in Paris. In 1897 he designed a cylindrical balloon, and fitted a small petrol motor to it. In 1901 he won the Deutsch Prize for a flight round the Eiffel Tower in his No. 6 Airship.

At this time discovery had been made of a cheap method of manufacture of aluminium, and magnesium, and of the useful properties of alloys of these metals. This led to the success of the next, and in many ways the most striking, attempt of modern times, viz., that of Count Zeppelin in Germany.

He had for many years devoted his fortune and energy to the practical study of aerial navigation, and had prosecuted experiments on a large scale. Forming a company with a large capital, he constructed an airship 420 feet long by 40 feet diameter, cigar-shaped. The framework was of aluminium, covered with oiled cotton fabric, having seventeen divisions. Each compartment contained a balloon of oiled cotton. A steering apparatus was constructed at each end. Two aluminium cars were attached to the body, and each carried a 16 horse-power Daimler motor that was reversible, and drove two four-bladed aluminium screws placed at the side of the body of the balloon. To strengthen the whole, a triangular aluminium keel of lattice work was used, carrying a moving weight. The trial trip took place in June, 1900, and was successful. This type is known as the Rigid.

In 1902 Lebaudy in France designed an airship of a new type, known as a Semi-Rigid. The distinctive features are that the cars are short and suspended from a long keel which is close up to the gas bag.

In 1906 Major Parseval experimented at Berlin with a new non-rigid type. The trials were most successful. The characteristics of the type are its unequalled portability, and a small car hung well below the balloon. Two balloonets, one near each end, are for trimming purposes. This can be effected by pumping air into either one or the other. The propeller blades are limp, and can be easily stowed for packing.

The present system of airship construction may therefore be divided into three divisions:

(1) *The Rigid*, in which the carrying body is rigidly con-

structed, as in the Zeppelin; a later French type known as the Zodiac; and a more recent German type, known as the Schutte Lanz, in which the framework is of wood.

(2) *The Semi-Rigid,* in which the carrying body is limp as in an ordinary balloon, but is fixed upon a rigid keel that supports the balloon underneath; such is the Lebaudy type, and also a later type in Germany known as the Gross.

(3) *The Non-Rigid,* which has neither a framework nor a fixed keel.

These constitute the majority of the different types of airships.

Aeroplanes and airships	Germany, America and France.
Dirigibles	France.
Seaplanes	America.

BENZOLE AND GAS

§ 1 Benzole

By Walter Groves, Editor of *The Motor*

HOW GERMANY PLANNED HER HIGH EXPLOSIVES SUPPLIES PARTLY AT THE EXPENSE OF ENGLAND

We all know that Germany laid her plans for the war with a cunning that knew no scruples and respected no conventions. It was in 1912 that a member of my firm made the discovery of a wonderful plant at a colliery in Staffordshire for distilling benzole from coal. At that time the need for an alternative home-produced motor fuel was impressing itself very forcibly on my mind. Great Britain was entirely dependent upon imported fuel-petrol, and this was trust-controlled. The plant to which I refer was, as was discovered, entirely German in design and construction, supplied to and erected at the colliery by Carl Still, of Recklinghausen, Westphalia, on something like the following terms: If a firm did not wish to pay for the plant, the Germans were ready to install it. They would put it up either free or for part payment until the amount owing was paid off.

Now let me put this in another way so that the reader may get a clearer idea of what it means.

First of all, let me say that the benzole industry had been started in Germany, and that it had been encouraged there by the German Government and closely watched and fostered by Prince Henry of Prussia, with the result that in the month ending June 30th, 1914, the benzole industry in Germany was immensely superior to that existing in any other country in the world. During that month the Germans were producing benzole at the rate of about 46,500,000 gallons per year. In this country the Government were not only indifferent to the industry, but when an opportunity was afforded of giving it some recognition and encouragement they positively refused.

Now it must be borne in mind that the Germans were exploiting benzole for a purpose other than using it as a fuel for motor vehicles. They were preparing in this respect, as in many others, for war. T.N.T. or tri-nitro-toluene is admittedly the highest quality charge for high explosive shells. Before T.N.T. can be produced, there must be an adequate quantity of toluene to tri-nitrate, and toluene is produced from benzole.

What was the position of this country, therefore, immediately before the war? It was this. Germans had been erecting enormous high-temperature coal distillation plants on British coal-fields on terms which I have already mentioned. They had already organized their own benzole industry to such an extent that they were producing 46,500,000 gallons of benzole a year. But British coal is richer in toluene than German coal, and *we actually allowed them to erect their own elaborate plants at our collieries practically without charge, the consideration being that they should have the yield of benzole and other by-products of almost equal value.*

Benzole produced in England was exported in quantities growing from 2,000,000 gallons in 1908, to 7,200,000 gallons in 1914. It was exported for the most part to Germany and France. In the latter country it was used in taxi-cabs and commercial vehicles.

We have in this recital of the respective positions of benzole production in Germany and England clear evidence of the far-sightedness of the former, and of the lack of it in the latter.

It followed as a consequence that at one period in the early stages of the war we were faced with a serious shortage of high explosive shells, and frantic efforts had to be made to supply the deficiency.

All supplies and every available source of output were taken

over, including the 70,000,000 gallons of benzole hitherto used at gasworks for enriching gas. But the fact can never be forgotten that immediately preceding the war, for which Germany was assiduously and craftily preparing, we were actually denuding ourselves of our own vital supplies for our best high explosive, and transferring material to Germany to help her, as it turned out, to fight us with.

WHAT OF THE FUTURE?

The future of benzole is a matter of the most vital importance to this country. When war is over the proper treatment of coal must become one of our staple industries. National economy demands it. We can never again return to the old wasteful use of coal. I published an article in *The Motor* in 1913, from which the following is a quotation: "The primary product of the future will be a smokeless fuel for all purposes: no more coal as mined will be burned openly. The secondary products will be the tars, oils and spirits with the by-products of pitch, gas, sulphates, etc. There will be a partition of the elemental combination in coal of the properties of heat, light, power and chemicals, and the ultimate effect will be more potent and telling than any previous change. Coal is one name for many things, more than one-half of which have up to now been wasted; but the coal mines of Britain will yet yield more wealth than the world's gold output."

These words, written three years ago, have an added significance now that the war has taught us so much, and it will be a lasting disgrace to this country if it ever slips back into the wasteful methods of the past.

The question that will arise in the minds of the reader now is: Can we do all that we should do independent of the huge German plants which have been erected here? There is no doubt in my mind that we can. We have in the low-temperature process, which is being improved beyond recognition, a British invention which is immensely superior to the German high-temperature process, infinitely more compact, less expensive to build, install, and work, and producing a greater yield at a lower cost. Furthermore, it can treat the baser form of coals, such as cannel, which is largely a waste product to-day. Such plants should be erected at collieries all over the kingdom, and coal should be treated so that all its valuable properties are extracted, and the residue will give us a perfectly

smokeless fuel. Our cities will be smokeless, our homes warmer, healthier, and cleaner.

To the motor industry the future of benzole production is of the highest importance. When we add to what we shall be able to produce by the low-temperature process the 70,000,000 gallons a year now set free from ordinary town gas for war purposes, and never likely to be used again for gas enriching, we shall have within our shores a plentiful supply of home-produced spirit, and we shall be entirely independent of the oil trusts.

§ 2 Gas Manufacture

THE processes of Gas Manufacture do not owe much of their development during the past thirty years to foreign influence. The discovery about thirty years ago of the incandescent mantle, which is due to an Austrian named Welsbach, undoubtedly gave a considerable impetus to gas as an illuminant, although for a time it had the effect of reducing the consumption. The use of gas for domestic and industrial purposes has so much developed in recent years that the increase in consumption for such purposes has more than made up for the loss caused by the adoption of the Welsbach mantle, and of electricity in private houses and public buildings and streets. But it is electricity that has given the chief stimulus to enterprise in gas development. Here the improvements have mainly originated in England.

In the latter part of last century the introduction of gaseous firing as applied to the heating of retort settings was carried out much more thoroughly in Germany than in this country. The name of Dr. Siemens is intimately associated with this improvement in the earlier years, though many later applications of the principle are purely British. Its general adoption has enabled high temperatures to be attained and larger yields of gas per ton of coal to be carbonized.

The utilization of vertical retorts in the destructive distillation of coal for the production of illuminating gas is a more recent innovation which originated in Germany, although such retorts had been used in this country for many years in the shale oil industry for distilling shales for the production of mineral oils, etc. They have not yet secured general adoption

in this country in the form in which they were first introduced, though other types since brought into use have been more favourably received.

The success of the Welsbach mantle having been assured, the control of the deposits of Monazite Sand, from which the rare earths used in their manufacture are obtained, was taken in hand by the Germans, and prior to the outbreak of war was very nearly secured, even in our own Dependencies. The Welsbach mantle however could not have attained success without a supply of heat-resisting glass for use as chimneys, bulbs, globes, etc. This glass came in abundance from Austria, as well as a supply of cheap burners for use with the mantle.

When the mantle became generally adopted, the thermal value of coal gas, as distinguished from its illuminating properties, was more promptly recognized on the Continent than in this country, where its importance is only slowly becoming recognized.

It is more particularly in relation to the disposal of the residual products of gas manufactures, viz., coal-tar products and sulphate of ammonia, that German influence has been more especially felt. It is well known also that a great proportion of the raw material used in the aniline colour industry is derived from gas works sources. Recent events have fully proved to what enormous extent this industry had been controlled by German firms.

Although the discovery of aniline colours was purely British, we failed to take advantage of it, and the industry has practically passed into the hands of the great colour firms of Germany.

Another important gas works residual is sulphate of ammonia. In this commodity also the Germans bid fair to control the market.

Until quite recently the Germans, although large producers of nitrogen fertilizers, have been importers rather than exporters, owing to the quantity used on the land. In 1914 however the production of sulphate of ammonia by a synthetic process was begun in Germany, and now the yield from this source alone probably exceeds 200,000 tons per annum. In 1900 Germany *imported* 21,000 tons more than she *exported*. In 1913 she *exported* 41,000 tons more than she *imported*—and that notwithstanding an increase of 335,000 tons in her home consumption in the latter year.

Incandescent mantles	Austria.
Gaseous firing	Germany.
Vertical retorts	„
Glass chimneys	Austria.
„ bulbs	„
„ globes	„
Coal-tar products..	Germany.
Synthetic sulphates	„
Aniline colours	„

TEXTILES

§ 1 Cotton Spinning and Manufacturing

THE inventions on which the modern cotton spinning and manufacturing industry was established were exclusively British. The principles on which the world's cotton trade was developed were, in fact, largely of Lancashire origin. Singularly, most of the early inventors were men who had no mechanical training, though they were engaged in one form or another in methods of manufacture that were associated with domestic production rather than with the factory system. The radical ideas were conceived and mechanically constructed by John Wyatt, of Birmingham, who invented a machine for spinning by rollers, patented by Lewis Paul, a foreigner, in 1738; John Kay, of Bury, who invented the fly shuttle and picking peg in the same year; by Lewis Paul who invented the card in 1748, and a mechanical doffing comb; by Robert Kay (son of John Kay), who invented the drop box in 1759.

The inventions which afterwards contributed more effectively to the progress of the industry were as follows:

Hargreaves's spinning jenny 1764, Hargreaves being a native of Blackburn; Arkwright's water-frame 1769; the wonderful spinning mule of Samuel Crompton, a Bolton hand-loom weaver.

The scutcher came in 1797, and was improved by Mr. Creighton's lap-end in 1847, and the piano-feed regulator by Mr. Lord in 1862.

The clever differential motion of Mr. Holdsworth was patented in 1830. In 1784, Dr. Cartwright, of Kent, introduced the power-loom.

All the above inventors were, with the exception of Lewis Paul, British.

To these may be added the invention of the self-acting mule by Richard Roberts in 1825. From 1800 to 1860 about 1,500 patents were issued in connection with preparatory, spinning, and weaving processes, in nearly all cases by British subjects.

Most of the inventions that have been brought out during the past seventy years have been developments in details. Few involved any new principle. Perhaps the "Heilmann" comber was the most effective innovation in the middle of the nineteenth century. The inventor was a native of Alsace. This was invented in 1845, and introduced to this country in 1856; it gave a great impetus to fine spinning, which became supreme in the districts of Bolton and Manchester.

A comber for dealing with short staple cotton was afterwards constructed by Messrs. Pinel, Lecœur, and Hethington, and was therefore of combined French and British origin.

The last of the pure inventions was the mule. Roberts, the Manchester engineer, brought out the self-actor mule in 1825. Since then the principal developments have consisted of improvements and additions to automatic motions. The main objects have been to increase speed and lengthen the machinery. Roughly, mules are about twice as long to-day, and the spindles are run at about double the speed. All driving, roller, backing-off, changing, and shaper motions have been improved, and whilst some of these have been due to experiments in America, France, Switzerland, and Germany, the majority of the patents have been designed by men of British birth.

The greatest change made from the principle of mule spinning was the invention of the ring-frame, adapted mainly for coarse counts. Its capacity for production is about fifty per cent. greater per spindle than the mule; that is, on given counts. One spindle on the ring-frame will turn out a quantity of yarn equal to one and a half mule spindles on the same counts. The ring-frame had its birth and early development in the United States of America. The first "ring" was completed in 1828, the inventor being an Englishman named J. Thorp. The next patent was issued by Messrs. Addison & Stevens, in which mention was first made of the traveller. The earliest patent taken out in England for a ring-frame was in 1834. This machine was originally used for doubling, and not for spinning. The real ring-spinning frame was made in Great Britain in 1867 by a British firm. The Rabbeth spindle

was of American origin, and was greatly improved by Messrs. Howard & Bullough in 1874. The double ring-frame was first made by a Preston firm. Spinning on the bare spindle has never been achieved with satisfaction, and has not yet attained any definite success. Though still in an inefficient state, it has been largely developed by an Englishman, Mr. Lancaster, who adopted the first traveller for spinning on the bare spindle. The effective use of the bare spindle in ring-frames provides the most considerable advance in spinning during the past three-quarters of a century.

The new finger space separator in ring-frames was British. There are several special "rings" and "travellers" now on the market of British and American origin. It should be remembered however that many of the improvements to cotton manufacture effected in the United States have been designed by mechanics and operatives who formerly lived in England. This is particularly the case with regard to the most significant changes made in weaving cotton fabrics, involving automatic weft-replenishing devices. The Northrop loom, for instance, was first designed by James H. Northrop, who was born in Keighley in 1857. He emigrated to America in 1881, where he began to work out patents for new looms. He completed the type of loom which bears his name in 1888. But this and other automatic looms have been mainly demonstrations of progressive ideas upon the power-loom perfected by Richard Roberts, of Manchester, in 1830. The United States have certainly provided the most encouraging opportunities for the development of the automatic loom. There has been no lack of inventiveness in Lancashire, which, however, has been retarded by the disposition to regard the ordinary Lancashire loom as better for the purposes of the trade. Among many authorities the shuttle-changing looms, or self-shuttling looms, of Lancashire are equal to those turned out from American workshops. The Crossley, the Hattersley, and the Dickenson patents (the last-named being the latest) will compare favourably with any of the foreign make.

Among other notable inventions in the cotton industry during the nineteenth century was the revolving flat card, and coiler, which were British, as was also the self-stripping card.

During the past twenty-five years, however, invention has been devoted to the improvement of devices of an automatic

character. These discoveries, which are numerous, came from all parts of the cotton-spinning and manufacturing world. The first principles were, it may be repeated, practically all British. The source of improvements has widened with the world extension of the industry, and has been mainly directed to the construction of labour-saving devices. A review of patents from about 1890 shows that Great Britain is holding her own. It would be difficult to get a sharp division of the countries to which the best of the latest innovations can be attributed. For instance, the Germans now turn out a number of patent pirn winders. Belgium has her specialities. The Universal rapid pirn winder, very much used in Great Britain, is of German origin. Automatic motions in regard to the self-replenishment of weft, come in presumably improved forms from Belgium, Germany, United States, France, and our own country. There are British, French, and German new types of combers. But it is contended that there are none to beat those made in Lancashire, nor is there anything that can excel the pirn winders used in Lancashire and Yorkshire, and made by local firms. Automatic winding had its origin in Great Britain, and steps towards getting a larger quantity of yarn in the shuttle were first planned and tried in this country. Exhaust dust removing, by automatic means, was first experimented upon in France. The condenser system of waste spinning was initiated in France. But the fact is that to-day improvements in all spinning and weaving processes are being constantly patented, or plans constructed, or devised, in Great Britain, France, Germany, United States, Italy, Switzerland, Spain, and Belgium. Most of them never come into use. But if a list of the localities of the inventors, or improvers, were compiled, it would be observed that in cotton manufacture the Briton is still holding his own with the rest of the world. One of the most ingenious machines, for reducing labour brought into use, of comparatively recent years is the Barber warp tying-in machine, which is of American construction. Whilst the Carver system for producing Jacquard design was British, electricity was first employed in card making about twelve years ago in Austria.

During the last twenty-five years "improvements" rather than "inventions" is the more correct term. These are very numerous, and the relative change that has taken place is that there is a larger proportion of these improvements designed in

foreign countries than there was in the last generation. The only effort made to revolutionize the weaving system was the construction of the circular loom which was of British origin. It failed, however, to secure the confidence of manufacturers.

The foregoing, covering briefly a period of nearly two hundred years, is interesting mainly as showing a tendency for the number of improvements which come from abroad in this essentially British industry to increase.

Some of the recent refinements in the industry such as the Individual drive for looms, the Electric warp stop motion, Universal winders, have had their origin and greatest development abroad. Mention should also be made of the Barber knotter (American)—an ingenious device for tying knots mechanically instead of by hand. It is interesting to note that in America the ring-spindle has found much greater development and general adoption proportionately than here, and this too is true of the automatic loom, of which there are said to be over a quarter of a million at work in the United States, whereas comparatively few are used here.

Ring-spinning frame	Great Britain.
Rabbeth spindle	America.
Northrop loom	,,
Self-shuttling looms	Great Britain
Revolving flat-card	,,
Self-stripping	,,
Pirn winders	Gt. Britain, Belgium, Germany.
Combers	Gt. Britain, France, Germany.
Automatic winding	Great Britain.
Barber warp-tying machine ..	America.
Barber knotter..	,,
Universal winder	,,
Individual drive	,,
Electric warp stop motion ..	,,

§ 2 Cotton Waste

By L. A. Porritt, M.I.M.E.

Cotton waste suitable for spinning into yarn is divided into two classes, one known as "hard," and the other as "soft." The former includes cop bottoms from the loom shuttles, ring-frame, reelers, and all waste of a thready nature. The latter

includes scutcher droppings, card fly, cylinder and flat strips, clearer laps, sweepings and comber waste, etc.

The majority of the waste spinning mills in England use "hard" waste as their raw material, and adopt either the "coiler" or "condenser" system of carding and spinning. The "condenser," which is a modification of the woollen system of carding, was introduced here about the year 1886, and tended to a great improvement in the levelness and fullness of the yarn, which was found to be particularly suitable for weft for sheetings, flannelettes, etc. The particular condenser attachment to the finishing carding engine is known as the "ring doffer" type. The "coiler" system, which is much older, is a simplified modification of the cotton system, and produces a cheap, strong, and serviceable yarn for weft for printed and dyed cloths, ropes, twine, etc. The coiler fixed to the finishing carding engine is fitted with four to six cans, which are next passed on to the slubbing frame, and then to the self-acting mule or ring-frame. English machinists excel in the manufacture of machinery to spin yarns from "hard" waste, and export to the Continent, the Colonies, and America.

English spinners cannot be beaten in the best qualities of yarn produced from either "hard" or "soft" waste. The Continental spinners excel in the utilization of the short stapled soft waste for cheap yarns and of dyed soft waste for yarns known as "Vigogne" to imitate woollen yarns. The preparing machinery is based on the lines of what is used in this country for the opening, cleaning, and scutching of cotton, and the carding and spinning machinery is based on that used in the treating of wool in this country. Low productive costs necessarily play an important part in the spinning of yarns, and where the aim is to make a good-looking article out of inferior staple, close attention to details is imperative. The carding process is the one which has received especial attention from firms in Belgium, Germany, and Austria. The "Bolette" steel tape condenser originated in Belgium, and the leather tape condenser has been largely developed and improved in Germany and Austria. With a view to large production for low counts, the carding engines of German manufacture are fitted with two doffers, the two fleeces being united before passing into the condenser. The working width of the carding engines is generally 60 in., 72 in., and up to 80 in., which is in accordance with the practice of the woollen

trade here, as compared with the standard width of 48 in. and 50 in. built for cotton waste in this country.

Increased production has compelled improvements to the cleaning power by addition of extra taker-ins, breast with workers and clearers, close fitting casings under the cylinders, etc., to prevent undue loss of waste, swivel bearings to the rollers, clearers, etc. The feeding mechanism between the breaker and finisher carding engines has been designed to give a wider web and for the fibres to enter the finisher card in the same direction as they leave the breaker card.

For the "Vigogne" and mixed yarns three carding engines to the set are commonly adopted with a different kind of feeding mechanism between the first and the second, and between the second and the third. The English Self-Acting Mule is not surpassed by any made in other countries, although here again Continental makers have given close attention to details so as to cope with large production, and were early in adopting the three-spindle speeds.

For very coarse counts (say ½s. to 3s.) we are indebted to a Frenchman, named Mons. Chapon, for his spinning frame, which builds a soft spun cop by means of an inverted flyer and cup from the condenser bobbin. The cop is known as a "jumbo"; it is solid, and is put into the shuttle without a peg. This form of spinning is universally used in the manufacture of cotton waste blankets.

Ring-frames have been experimented upon, with a view to producing a yarn to imitate a mule yarn, by firms in Belgium, and later by those in Germany and Austria. The main feature is the arrangement of drafting rollers with a twist tube in between, before the thread passes to the ring and spindle. This type is now built in England, and is not equalled on the Continent as regards design, construction, and simplicity.

All of the above named types both on the English and Continental systems are being built in this country, and although English machinists were late in adopting the more recent improvements, they are now ready to supply to spinners in any part of the globe with equal, and in some cases superior construction to what is made on the Continent. There is every prospect after the war of big developments, especially of soft waste spinning, to meet the demands of cloth buyers with less money to spend than previously.

List of Cotton Waste Spinning machinery in general use in

the United Kingdom and on the Continent, showing the countries where the greatest developments have taken place:

Willows	Great Britain.
Thread extractor for sweepings..	Germany.
Breaking-up machine for thread and cop waste	Great Britain.
Scutching machinery	,,
Hopper-feeders for scutchers ..	America.
Carding engines for "hard" waste	Great Britain.
Carding engines for "soft" waste for best quality of yarn ..	,,
Carding engines for "soft" waste for large production and for lowest grades of waste ..	Germany and Austria.
Carding engines with double doffers	,, ,,
Automatic feeders for carding engines	,, ,,
Parallel fibre cross feeders ..	Germany.
Continuous lap formers	Germany and Austria.
Leather tape condensers.. ..	,, ,,
"Bolette" steel tape condenser..	Belgium.
"Vigogne" carding engines on the 3-set system	Germany and Austria.
Slubbing frames	Great Britain.
Self-acting mules	,,
"Chapon" frames	Great Britain and Belgium.
Ring-frames	Great Britain.
Ring-frames with special drafting rollers to imitate mule yarn ..	Great Britain and Belgium.
Universal winders	America.

§ 3 The Woollen and Worsted Industry

By F. A. Hunter

The British woollen and worsted industries owe less than do some others to foreign inspiration and assistance, and fairness demands some acknowledgment of the enormous improvements wrought by British effort before we pass to any mention of foreign achievements. Except Heilmann, who invented one type of wool comb, all the great primary inventors of machinery were Englishmen, and English textile machinists have done far more than any to perfect the work of the fathers of the manufacturing trade. In their own line, British woollen

and worsted manufacturers are unexcelled, and they draw most of their methods and materials from British sources. Certain other lines have been abandoned to the foreigner, who has probably not done better out of these than the Englishman out of his own.

Conspicuous instances of lines of trade that the English have not troubled to develop may be named. Englishmen have put on one side the classes of wool which need carbonizing (for the extraction of burrs) before spinning, and the best work in that direction has been done at Verviers, Belgium. These wools are those most suitable for the production of soft, full dress goods, the speciality of the French, and only in the dearer fabrics of the sort have the English been able to compete. The yarns to weave the goods are mule-spun worsted, combed upon Heilmann machines, and this branch of worsted spinning has been left almost entirely to the French, Belgians, Germans, and Americans. The making of certain cheap woollen hosiery yarns has been mainly in German hands, and that of finer woollen yarns needed for shirtings in Belgian. These yarns are produced by the aid of Continental systems of carding, which have been little employed in this country. The materials, methods, and machinery being different from, but not superior to, the British, it follows that a distinctly different class of goods has been made.

There are machines of British manufacture which have found their chief employment abroad. The self-doffing worsted spinning frames for economizing labour in spinning have been taken up more enthusiastically in countries where wages are lower than in England.

Tapestry looms are largely made in England, but tapestry weaving has been done mainly abroad. Braids, boot laces, and plushes, made entirely from English worsted yarn, have been procured even for the English market from Germany. To the foreigner, and notably the German, has been left the unimpeded use of large quantities of by-products and short wools with which to produce cheap imitations of English goods, and by patience and industry clever use has been made of the opportunity.

Few machines in the British mills are foreign-made, but attention may be called to some that are of foreign inception. Belgian types of condensers are used in carding woollens. American machines are employed in winding yarns to put the

maximum of length into the minimum of room. In cloth finishing the German system of decatizing with dry steam is widely used. Automatic looms, the invention of an Englishman settled in America, are gradually extending in use. In the dye-house several of the most valuable improvements in yarn—and slubbing—dyeing machines are American, Belgian, and German, and everybody knows our dependence for dyes upon the Continent.

Wool carbonizing	Belgium.
Worsted mule spinning	France, Belgium, Germany.
Fine woollen spinning	„ „ „
Yarn winding machinery ..	America.
Self-shuttling looms	„
Dyeing machinery	Belgium, Germany, America
Cloth finishing machinery ..	Germany.
Warp sizing machinery	France.
New dyestuffs	Germany and Switzerland.

§ 4 The Silk Industry

By Frank J. Farrell

The Silk industry is one which for various reasons, mainly economic, has declined very considerably in this country since the middle of the last century. It is not germane to the present question to consider the causes which have contributed to this decline, and to the revival in the industry which is now taking place. One undoubted cause however must be considered, namely, the effect of the introduction by Continental manufacturers of the process of tin "weighting." By this process the weight of the fibre is increased by anything up to 100 per cent., as a usual basis of working, though very much greater increases are not unusual. This process has revolutionized silk manufacturing, and the reluctance of English manufacturers to take it up has contributed in some measure to the decline of the industry. The late Sir Thomas Wardle, more than twenty years ago, investigated and condemned the practice of excessive silk weighting, but the general tendency of English manufacturers was to condemn weighting *per se*, whilst the Continental manufacturers were doing a huge trade.

Excessive weighting, or the imperfect manipulation of the process, undoubtedly produces an article greatly impaired in

wearing qualities, and quite fairly describable as an adulterated article. On the other hand, it must be considered that in these days when fashions change from season to season and an article of dress becomes old fashioned before it wears out, it is of no great economic advantage for one manufacturer to produce a pure fabric which will "wear for ever," while another manufacturer will produce a similar "weighted" fabric at a much lower price, which will wear quite as long as the purchaser wishes or expects it to wear. The process is admittedly complex, and requires expert chemical control to carry it out satisfactorily, and it is to be feared that in many instances the English manufacturer has defended a course of action on ethical grounds, when as a fact the real motive was the desire to evade a new and difficult process. Many manufacturers have now recognized that their point of view was incorrect, and that, by adopting processes which give the public *what they want*, they are capturing some of the trade hitherto done by their foreign competitors.

From a mechanical point of view, the English silk trade has, from the mere fact that it was a declining industry, depended in some degree on American and Continental manufacturers for improvements in winding and doubling machinery, which is specially designed for the industry; in looms that is not the case. The American lapping mills have no equivalent made in England, and the Swiss "Rapid" winding machines build a pirn holding nearly twice the yardage of yarn as English-made machines.

Artificial Silk.—The manufacture of an artificial fibre equalling or excelling silk in brightness represents one of the romances of chemical industry. It is one of the few products where the original inventor carried out his ideas on an ultimately commercially successful basis.

The Comte de Chardonnet was able to establish his process at Besancon at Tubize and other centres on the Continent on a highly successful basis; yet the highest and most profitable development of the root idea—though the process differs chemically from that of Chardonnet—has been made in recent years in England by Courtauld & Co. Ltd.

After passing through an experimental period involving a large outlay of capital, this firm has developed a process giving a more satisfactory fibre for weaving, and producible at a lower cost than any of their Continental competitors. The

financial success is proved by their balance-sheets, and by the fact that the market value of their shares represents a sum of considerably over twelve millions sterling. This is a rare and interesting example of an idea of foreign birth reaching its highest development in this country.

Winding and doubling machinery	America and Europe.
"Weighting" process	Europe generally.
Artificial silk	France and Gt. Britain.

§ 5 Knitting and Hosiery Machinery

THE first stocking frame was invented in 1589 by the Rev. William Lee, of Calverton, Notts., and met with great discouragement. In 1740 Jebediah Strutt invented a machine which gave a great impetus to the trade, but the first rotary machine was invented and patented by William Cotton at Loughborough, Leicestershire, in 1864. In these machines patent after patent developed slowly in this country, but during the last twenty-five years, as the main patents have lapsed, the increase in the production of the machinery in Germany in particular has been remarkable. For example, twenty-five years ago Germany and the United States took something like half the British production of the Cotton's Patent Machine. In 1914, when the original patent had lapsed, Germany had taken practically the whole of the business of the United States, also that of other countries by their lower prices and better methods. In this way has arisen the enormous hosiery machinery trade of Chemnitz. Prior to the war there was great competition in Canada, Australia, New Zealand, etc., but Germany was always out to cut down prices to a level to which few English engineers could descend, and it is worthy of notice that in the important hosiery centre of Nottingham there had been established a German depot for the supply of machines made in Chemnitz.

In regard to the Latch Needle, which plays so important a part in hosiery manufacture, this was invented in 1847 by Matthew Townsend. During the last thirty years the making of needles in this country has gradually died out, and it is significant that at the commencement of the war the hosiery trade was faced with a great shortage of needles. At the present date this has been partially overcome by the

establishment of several factories entirely for the purpose of manufacturing needles. The fact that the Latch Needle, although invented in England, was developed and ultimately manufactured for the most part in America has resulted in many plain automatic knitting machines being imported from there.

Generally speaking, the building of hosiery machinery based upon inventions and ideas originally conceived in England has been submerged by the foreigner. It would be difficult to give briefly the reasons for this state of affairs; primarily it must be admitted that in the main his methods have been more modern and scientific than those of his British competitor.

In the actual manufacture of hosiery, except in the lighter grades of hose, shirts, pants, etc., we have during the past twenty years quite held our own.

Rotary machine	Gt. Britain and Germany.
Latch needle	Gt. Britain and America.

§ 6 The Asbestos Industry

THE Asbestos industry is one which fully confirms the general claim of the authors of this book. The industry was started in this country about forty years ago, and manufacture was simultaneously carried on by Italy and America.

For the first fifteen years or thereabouts the English firms were supreme, but since then practically all the new uses and developments of an important character have been given to the world by Austria, America, or Germany, the reason for this, in the writer's opinion, being that these countries earlier realized the intimate and close relationship between chemistry and industry, and acted accordingly.

As a result, the new products and inventions came from these countries, and not only so, but their consumption of asbestos increased enormously. Thus we find that before the war America consumed much greater quantities of asbestos per head of population than Great Britain, and this is true of Germany too. This illustrates the truth that a new and unexploited product is found to develop more rapidly in countries possessing the "scientific habit of mind," which Germany and America do possess, and which Great Britain does not. It is necessary for the people who are to use a commodity to

be able to see its scientific and industrial value, if it is to come to full development rapidly.

Signs are not wanting that the early supremacy of Great Britain is being regained, but the industry here can only maintain itself by putting forth a greater amount of effort by way of research and mechanical experiment than it has done in the past.

As would be expected where the technique of an industry goes abroad or is born there, the machinery of the industry is ultimately built in the same place; thus latterly, the best machinery for manufacturing many varieties of asbestos was only obtainable abroad, but English engineers have since put themselves in a position to do equally well and meet all requirements.

As examples of the developments in asbestos, which in their sum total confirm the foregoing statement, the following may be cited:—

Asbestos roll roofing	America.
,, building felt	,,
,, sectional and removable covering	,,
Asbestos cement slates	Austria.
Asbestos cement building sheets	,,
Compressed asbestos fibre jointing	,,
Asbestos brake band lining ..	America.
Fine spun goods for electrical purposes	America and Germany.
Filtration by asbestos on a large scale	Germany.

AGRICULTURE

§ 1 Agriculture

By F. E. W.

AGRICULTURE, the greatest of industries as it is sometimes called, and certainly the most ancient, has also been the last to recognize the value of scientific methods, and it is only comparatively recently that it has sought and received the help of scientific investigators. Possibly this is owing to its very antiquity that it has for so long relied upon its own initiative, and continued in its old ways. But the demands now

made upon agriculture are greater than they were formerly. In most countries there is a larger population to feed, and in industrial countries the disproportion between the factory workers and the agricultural population is steadily increasing. Moreover, owing to cheaper and quicker methods of transit, the British farmer has to compete not only with the agriculturist of neighbouring countries, but also with the settlers in our colonies, and with other inhabitants of vast virgin tracts where cultivation of soil takes place on a large scale, and where crops are grown on land which bears little or no rent, so that production can take place comparatively cheaply. It becomes therefore more important to increase the yield of the land by better methods of cultivation and by the selection of improved strains.

The productiveness of British agriculture has always been comparatively high, and the yield per acre in England and Wales is usually higher for such foods as wheat and potatoes than it is in Germany, Austria, France, and Russia, and also than in Canada and the United States. But the productiveness is not as high as it might be, and our rate of improvement has been slower than in some of the other countries. We ought rather to compare our yield with that of the smaller countries in which increased productiveness is of supreme importance. In this respect England lags behind Scotland, and is still less productive than Denmark and Holland as regards its yield of wheat per acre. In Denmark where agricultural education and co-operation have been greatly developed during the last thirty years, the yield per acre of wheat has increased by 7½ per cent. during the last twenty years, whereas in England it has only grown 2½ per cent. It is obvious therefore that a more strenuous effort must be made to perfect our methods and organization, so that we shall be able to compete with those vast areas in America and Canada where cheaper methods of production render the farmer content with a comparatively low yield per acre.

To give but one instance. The yield of potatoes might be very considerably increased by better attention to spraying against such a disease as late blight. Scientific experiments in America have shown that fields systematically treated with suitable sprayings at a small cost will yield an increase of about one ton per acre over unsprayed fields. Yet in many parts of England little or no spraying of potatoes takes place, with a

consequent loss both to the farmer and to the country. But quite apart from the question of the efficiency of our methods of agriculture, it must be remembered that during the last forty years three and a half million acres have passed from arable land into grass land—which means, as Mr. A. D. Hall, one of the Development Commissioners, points out in *Agriculture After the War*, a very considerable loss in the productiveness of the land. For even if we recognize the importance of raising cattle in this country for the production of meat and dairy produce, it would be possible, according to Mr. Hall's calculations, to raise more than twice as much cattle food from arable land than is obtainable from permanent grass.

Lastly, we have also to reclaim those large tracts of our country which must still be considered as waste land. The reclaiming of salt-marshes, sand-dunes, moorland, and peat bogs, and their transformation into fertile tracts under cultivation or woodland, still awaits individual or State enterprise. The Royal Commission on coast erosion and afforestation, in its report of 1909, estimated that there were in Great Britain and Ireland eight million acres of mountain and heath lands which could be profitably brought under afforestation, in addition to 1,000,000 acres of poor tillage land which would be more remunerative under wood. We see therefore what a vast field there is for the improvement in the productiveness of our country, if intelligence and energy are brought to bear upon these problems. Their solution will however also depend upon the education and research which must be concentrated upon the difficulties with which they are surrounded. Something has been done of recent years by the Board of Agriculture to improve agricultural education and investigation, but much remains to be done. We are not equipped like such progressive countries as Germany, Sweden, the United States, and Canada, with State Experimental Farms and Institutes for dealing with the breeding and selection of new varieties of cereals, and with other agricultural problems. Nor have farmers the advantage of help and advice from seed testing and control stations, such as those of Copenhagen, Zurich, Wagensugen (Holland), Vienna, Budapest, Hamburg, Munich, Breslau, and Berlin. What has been done in England has been done mainly by private enterprise, such as at the Rothamsted Experimental Station, the John Innes Horticultural Institute, and by certain Colleges and Universities aided

by grants from the Board of Agriculture. Much remains to be done by the Government through the Board of Agriculture before the farmer or the horticulturist can be considered to be receiving that scientific enlightenment and practical help which he deserves, and to which he is entitled. With such assistance there is no doubt that he will successfully overcome the difficulties with which he will have to cope in increasing the productiveness of his land, and in bringing comparatively poor land into a high state of cultivation.

INTERNATIONAL CROP REPORT AND AGRICULTURAL STATISTICS
YIELD PER HECTARE IN QUINTALS[1]

1913-4

	Wheat.	*Rye.*	*Barley.*	*Oats.*	*Potatoes.*
England ..	21.7	—	18.4	17.3	160.6
Scotland ..	28.5	—	21.3	17.6	177.6
Ireland	25.8	18.5	25.2	22.1	148.4
Denmark ..	29.1	11.5	20.5	16.0	154.7
Holland ..	25.0	16.4	25.8	20.7	150.0
France ..	12.7	10.5	13.5	12.9	80.6
Germany ..	19.9	16.6	19.8	20.6	134.6
Austria ..	15.4	14.9	18.2	16.7	108.1
Canada ..	10.5	11.4	13.0	11.9	121.1
United States ..	11.2	10.6	13.9	10.6	73.6

It is interesting to see how Scotland is invariably better than England, and so is Ireland, except, curiously enough, in potatoes.

Germany is better in oats and barley, but worse in wheat and potatoes.

Denmark is better in wheat and barley than England, but lower in potatoes.

§ 2 Agricultural Machinery

THE detail of the Machinery of Agriculture is not given here for the reason that we find it possible to sum up the position as follows. This machinery had for the most part been given to the world before our period by America, although much of its development to the present high state of efficiency has taken place during the last forty years. America to-day manu-

[1] Published by the International Agricultural Bureau in Rome.

factures such an overwhelming percentage of the world's Agricultural Machinery that she dominates the market in most countries. We append a list of the machinery deemed necessary for the average American farm as given to us by the Iowa State College of Agriculture and Mechanic Arts :—

Grain harvester with self-binder.
Mower.
Gang plough.
Walking plough.
Riding cultivator.
Disc harrow.
Smoothing harrow.
Farm wagon.
Corn planter for checking and drilling.
Manure spreader.
Hay loader.
Hay rake.
Light road wagon.
Buggy.
Light gas tractor.
Grain seeder.

Just as the automatic machine tool given to the world by America has multiplied beyond calculation man's capacity to produce, so has the machinery of agriculture increased a thousandfold the yield of Mother Earth. So much so, that the spectre of famine, once so haunting to the mind of man, has been banished for ever.

Agricultural Machinery and the Cheap Loaf are "Cause and Effect."

§ 3 Fertilizers

This country uses Fertilizers to a much more limited extent than is customary on the Continent, particularly in Germany.

In this as other products depending for their success in manufacture and use upon scientific knowledge, the greatest developments of the last twenty-five years have taken place abroad.

The most far-reaching discovery of modern times is the extraction and fixation of atmospheric nitrogen, and this we owe to the foreign scientist.

The same story may be told of synthetic sulphates.

In a word, this field is one offering vast opportunities to British brains and labour.

§ 4 Beet Sugar Production

GREAT Britain imports every year sugar to the value of over £23,000,000, of which, in the year before the war, Germany and Austria alone contributed £15,000,000 worth—roughly two-thirds of the total.

Great Britain is almost alone among European countries in having done nothing to encourage the cultivation of sugar beets. Had everything else been as favourable as the climate, the sugar beet industry here would most certainly have flourished, and would have been in an exceedingly healthy condition by this time.

Our Home supply and our Imperial resources only need to be developed to make Great Britain and the Empire quite independent of the foreigner for this commodity.

This may be cited as a case where new developments have been demonstrated, and given to the world, by countries other than our own, and as a glaring example of what may be accomplished by the scientific utilization of our own opportunities.

§ 5 Barb-Wire

WHILST the invention of Barb-Wire must be accredited to America, many of the improvements both in the article itself and in the machinery for producing it had their origin in British brains.

The manufacture of barb-wire in Great Britain was begun in the year 1877, the machine used being of a slow running and crude type. The utility of the article quickly became apparent, especially in the colonies, and to cope with the ever-increasing demand, constant improvements in machinery have been necessary with a view to rendering possible a far greater speed in manipulation. Moreover it has been found in practice that the different markets of the world do not by any means favour the same type of barb-wire. What suits one will not suit another, and to meet the peculiar requirements of each has

involved a vast amount of study and experiment. As with other articles, the American manufacturers of barb-wire favour the policy of turning out bulk supplies of a standard pattern, with the result that the designing and perfecting of the different styles of barb-wire to suit the different markets has devolved almost entirely upon the British manufacturers.

The question of galvanizing in order to ensure the longevity of the wire (a most important feature in barb-wire) is also one to which British manufacturers have given great attention.

Another great problem which involved considerable experiment before it was solved was the question of a suitable reel on which to wind barb-wire, so as to bring it within the limits of the space per ton allowed by the Shipping Companies, whilst at the same giving the full guaranteed length of wire on each reel. The reel at present used by the English manufacturer has been found admirably adapted for this purpose, and all trouble in this respect is now happily a thing of the past. To sum up, we claim that the evolution of barb-wire from the crude state in which it was first introduced into this country to its modern degree of perfection has almost entirely been brought about by British brains and by British labour.

In the matter of production, America is far ahead of Great Britain, owing to the system of tariffs, etc. American firms are able to deposit in England large quantities at such low prices that British makers cannot compete even in the home market, though they more than hold their own in exports to the Colonies.

Barb-wire	Great Britain.
Standardization	America.

DOMESTIC

§ 1 The Departmental Store

By Dale Tritton

The Departmental Store is the inevitable outcome of the tendency of civilized forces towards fusion.

There comes a point in the conduct of affairs when supreme efficiency can only be gained through co-ordination. Macey in America and Wm. Whiteley in England were the first men to catch a glimmering of this great truth. They linked up a

series of little shops under one roof and organization; made, each in his own country, a small, composite Distributing Centre, which was ultimately called a Departmental Store.

It was two other American business men however who were responsible for the most brilliant developments resulting in Stores which are to-day almost public institutions. These men were John Wannamaker, of New York, and Marshall Field, of Chicago.

They re-discovered the first principle of trading—which is *service* in its completest form. They made their great centres of distribution indispensable to the community. Outward dignity was given to their plans by fine architectural design; inward dignity by their breadth of vision, which originated trading policies—now models for the shopkeeping of the entire world.

Until their inspiring notions revolutionized the retail world, the act of selling was coloured more by the idea of "doing" the public than serving it. Their methods lifted salesmanship on to a plane of morality so high that people thought them mad, unpractical, altogether too visionary to be business-like.

These stores and their contemporaries have welcomed every new invention that made for greater efficiency and ease. The telephone, typewriter, lift, adding machine, cash register, card index systems, central heating, electrical discoveries, automatic parcel carriers, motor delivery—all such scientific innovations they have god-fathered and perfected in use.

A first-class modern store is perhaps the best all-round illustration of how far invention has simplified life.

Taking these points in which the influence of the departmental store has been most revolutionary, and placing them in the order of significance, we find:

1. They have delocalized trade.

   They draw their customers from far and wide.

2. They have become exhibition centres for the merchandise of the world.

   People visit them as they would a picture gallery; and this would not be possible without the stores' far-sighted abolition of the ancient obligation to buy.

3. To an unprecedented degree they have done away with the services of the Middle Man. A big departmental store buys direct from the producer, which means an enormous saving of money, energy, and time.

4. They have greatly influenced the morality of trading by abolishing forced sales.

   If a transaction is in any way unsatisfactory, the customer may send back the goods and get his or her money returned in full. One of Marshall Field's most famous maxims was: "The customer is always right."

5. They have had a socializing influence upon society. A modern store is both Club and Rendezvous. It enlivens people's minds by its gaiety and bustle, its great variety of interests, and charming self-dedication to the art of pleasing.

6. They have realized that there is a close relationship between Art and Commerce, and so they have influenced Taste. Chiefly they have learned to use Architecture Decoration, Typography, and Design with proper effect.

7. They have helped to make the fortune of the Press, since their ideas and facts about their merchandise are made public by advertisement. Their mastery of this science is second to none.

To sum up—one might say that these trading institutions have solved the secret of success, because they have acted consistently from motives that are sound from the three great points of view—Morals, Economics, and Psychology.

§ 2 Incandescent Gas Mantles

Gas Mantles such as were first put on the market were invented or originated in Austria, and developed there to a very large extent. The Welsbach Companies, floated in Germany and elsewhere, were all under German control, and it may be said that the Continent had the monopoly for a number of years and up to the time of the war the trade was still very largely Continental.

The chief ingredient in the manufacture of the above is Thorium, a product obtained from Monazite sand, this latter being the raw material supplied by India and Brazil. Prior to the war, Monazite sand was under German control, both in India and Brazil; subsequently, however, and so far as India is concerned, the Indian Government has stepped in, and an official was appointed to safeguard our interests and to ensure none of this sand getting into German hands.

Of the number of mantles used annually in England before the war, thirty-five millions were made in this country, whilst sixty-five millions were imported, chiefly from Germany. Since the beginning of hostilities, however, it is pleasing to note that we have increased our production to such an extent that probably 90 per cent. of the mantles sold in this country at the present time are of English manufacture.

In regard to the inverted ring (china clay) used in connection with these mantles, this was the result of an English patent, but the Germans copied it, and used means to manufacture so cheaply that they were soon in a position to monopolize the markets of the world in this article. It was not until 1914 that these rings were made in any quantity in this country. Also with the ramie fibre, which is used as the base, we find that it was mostly manufactured in Germany.

Thorium (use of) ..	.. Germany.
Inverted ring ..	.. Gt. Britain, developed in Germany.
Mantles	.. Austria.
Ramie fibre (use of)	.. Germany.

§ 3 Pottery

By Bernard Moore

The art of Pottery-making was practised in ancient times, and the various methods have been handed down through the centuries, each contributing to its development. England took the lead in many of the principal types of pottery, and has maintained her supremacy, although repeated attempts have been made by other nations to usurp her place. Among the leading types in which England is supreme, might be mentioned :—

Bone china : We are a long way ahead of other nations, and though imitations have been many, there are now only a few small factories on the Continent.

General earthenware : In the best qualities, English ware is the type for the rest of the world. This is fully acknowledged by the French and the Germans.

Parian : In both glazed and unglazed, England was the originator, and is still ahead.

Jasper ware and also Wedgwood : There is no other country in the world which can compare with England.

Hard porcelain was made experimentally in England more than 100 years ago, but owing to the fact that it was not properly developed, it has never been a success in this country. So far as its manufacture is concerned it is practically non-existent in England. This porcelain has been made very largely in France, Germany, and Austria; and is the most suitable for making chemical appliances. Practically the whole of this trade and its ramifications have been allowed to drift into foreign hands.

The success that England achieved in other types mentioned made her very conservative, and she has been slow to take advantage of improvements, and has allowed many profitable products to be made abroad.

Among the important processes which have been brought out, the system of making the clay in filter presses is an English invention, and is now in universal use.

Casting by adding solutions to slip was a French invention, but Germany was quick to appreciate the utility of it, and rapidly developed it. This method has now been adopted here, and is in almost universal use in England. England was very slow in taking this up. Since its adoption, however, it has revolutionized the manufacture of certain classes of pottery.

Chromo-lithography: This is a French invention, Germany adding her share, and both countries developed the industry very largely. Later on the English makers realized the utility of this process, and made use of it. It is now being successfully carried on in this country; though many of the prints are obtained from abroad.

Liquid gold was a German production, and it practically controlled the world's market for many years. We are now making this liquid gold satisfactorily in this country. There has been an enormous quantity of liquid gold used for quite a number of purposes, and the trade has developed accordingly.

Colours—English colours for the pottery trade: These are pre-eminent, and the English manufacturers have maintained their supremacy. Quite a large business has been done on the Continent by them.

Germany has paid much more attention in the past than England to the requirements of the chemical industry. In special fire-bricks, retorts, etc., she is certainly ahead of England, in spite of the fact that we have undoubtedly equal if not better raw material in these islands.

Hard-paste porcelain: In the making of hard-paste porcelain Austria, France, and Germany, up to the beginning of the war, had the monopoly, but now the Government has given a large grant for research work to be conducted on a manufacturing scale with a view to the adoption of suitable means for the making of this porcelain in England. Every hope is entertained that the venture will be eminently successful—British materials being exclusively used.

Pottery machinery: England is very well placed as regards quality; even foreign pottery-makers when requiring the best quality come to this country for their supplies. The foreigner set himself out to create a market for cheap goods, and to a certain extent succeeded; his policy seemed to be one of reducing price.

Whilst England has allowed the foreigner to take quite a large share of the pottery trade, there is no reason why she should not again be pre-eminent. She has the necessary talent, if she will but develop it, and also the necessary raw materials.

We have not been scientific enough in the past, and while England has kept to a few types, the foreigner has slipped in and wrested the remainder from her.

Best-class glazes and ornamental ware; England has fairly held her own in this class, although we have had severe competition from Continental firms, particularly from some of the French firms, who were very good at this class of work.

To sum up—we have held first place for the better class of ware, but in the cheaper lines, the foreigner has been first to appreciate the requirements of the people at large, and therefore secured the larger portion, if not all, of the trade.

Enamel industry: This is really an English industry. It has not, however, been developed to anything like the extent to which it has in Germany. The latter fostered and developed the industry to a considerable extent, and up to the time of the war, exported considerable quantities of enamel goods to England.

Thus it will be seen that the foreigner is a better imitator than originator—so far as pottery is concerned. Notwithstanding this he has succeeded in developing the industry in far greater measure than have his British rivals. The reason of this is to be found not only in the early adoption by the foreigner of exact and scientific methods, but also in the manufacture and distribution of his products.

Bone china	Great Britain.
General earthenware	Best qualities—Great Britain. Competitive—Germany.
Parian ware	Great Britain.
Jasper and Wedgwood ware ..	,,
Hard porcelain	France, Germany, and Austria.
Filter presses	Great Britain.
Casting	France and Germany.
Chromo-Lithography	,, ,,
Liquid gold	Germany.
Colours	Great Britain.
Ware for chemical industry ..	Germany.
Hard-paste porcelain	France, Germany and Austria.
Pottery machinery	Great Britain.
Glazes and ornamental ware ..	Best—Great Britain. Competitive—France.
Enamel industry	Germany.

§ 4 Glass-making

THE origin of Glass-making is obscure, though Pliny says that fishermen, lighting their fires by the seaside, observed that the prevailing basaltic rock with the shells and sand of the beach and the dry seaweed (kelp) lying about became fused into a conglomerate, and that, seeing possibilities therefrom, the ancients gradually developed glass.

Though their methods were crude, the Romans produced fine results—notably the incomparable Portland Vase. Later on, glass-making was confined to certain families and their descendants. The Venetians were the most skilful. Afterwards, the invention of printing, and the general dissemination of knowledge, leavened the arts and science, though glass-making was among the last to advance.

Judging by the French names of some of the tools used in Great Britain it may be inferred that the French introduced glass making amongst us. Under their French instructors, our men eventually eclipsed their teachers, for at the Exhibition of 1851 the British won the gold medal for crystal ware.

The British workman, when intelligent, is industrious, resourceful, and inventive; but the owners, employers, and fore-

men are often asleep, rejecting useful innovations, and letting our best men go abroad. All through U.S.A. and Canada there are many Britons doing well—men whose inventions and discoveries have been ignored in England, but recognized in America.

In America almost every nationality is represented at a glass works. A smart foreman seizes hold of their various best points, and groups their methods, thereby outclassing the peculiar methods of the different nations. For instance, in America, in making bottles by hand, two men gather glass and blow bottles in two moulds, open and shut by one boy, who, seated, places each bottle in a punty, to be taken up by a second boy, and added to three other punties, each holding a bottle, which are rewarmed at the mouth to plastic condition at a slotted glory hole. This second boy places a punty, carrying a sufficiently warmed bottle, upon the long arms of a special chair, upon which the finisher sits continuously, to finish the mouths of the bottles. A third boy removes the punty holding the finished bottle, and places the bottle in the conveyer travelling alongside to the annealing bar, and so on. Each person works with ease, contentment, and comfort, for in warm weather cooling air is always being blown upon him, and upon the moulds. There are six hands in all, making at least sixteen bottles a minute, say of 8-oz. capacity. Compare this with an English group of four hands, making three bottles a minute.

The American bottles cost in labour less than one-half of the British. If the American method were adopted, the Briton would make more money, even if the present scale per gross were reduced one-half, because he would make at least four times the quantity.

In Australia, in 1876, a machine for making pickle bottles was made, but the men obstructed its development. Ashley in England tried and failed. Then there was a lull. But minds are busy, especially in America. About twenty years ago the Blue machine successfully produced wide-mouthed bottles, making eight half-gallons, ten quarts, or twelve pints a minute respectively. The Haley, Ball Bros., Pyles, and scores of others quickly followed, notably Owen with his machine, made at Toledo, Ohio, fourteen years ago, which now produces up to fifteen quart bottles per minute, or twenty-four of small size. The latest Owen machines have fifteen

arms; each arm carries a complete machine, which dips the blank mould into molten glass within a rotary basin, and sucks up, by a vacuum, the exact quantity of glass for each bottle. The whole process is absolutely automatic. It is a costly and ponderous machine, but marvellously ingenious. The original patent has just expired. The Owen's Company have a capital of $50,000,000. They acquire stock in all works using their machines in America. There are now about 200 at work in America; a dozen or so on the Continent of Europe, and a few in England. It would be better if American machinists familiar with the mechanism were employed to look after them.

In Europe and America many patents for machines continue to be registered. Some indicate considerable merit. Naturally the war retards progress; but the time is opportune.

The American crystal glass now ranks with the British, but is produced at one-third the cost. Both ladle the glass into moulds and press firmly—the British in respect of cheap ware, the Americans for both cheap and best ware. The best ware is smoothed and polished first mechanically, and afterwards by fire. A most brilliant lustre is thus produced, and the article is finished. Compare this with the tedious British method, where every stage of progress requires the utmost skill and care. First, comes the gathering of the glass; secondly, the marvering and the blowing; then the shaping and the forming of lips and curves, the attachment of legs or handles, the frequent reheating at glory holes; and finally the annealing. When annealed and cool, the design has to be artistically scrolled, then rough-cut by wheels, water, sand, and emery, true to the scrolling; then it is smoothed and polished mechanically, for fire-polishing may cause cracking, owing to the deep cutting disturbing the molecules of the glass, and rendering it susceptible to fracture. The American moulds are beautifully cut, producing perfect ware. But the English still adhere to the difficult methods of fifty years ago, which require twenty times the labour.

Presses for making solid or open vessels have almost approached automatic perfection.

Window glass, hitherto blown, is being successfully made by machines in America. Probably similar methods are being exploited in England.

The supply of glass to moulds for both bottle machines and presses has been perfectly attained by the vacuum process of

Owen. The flowing-out process seems to be next in merit. Rotary knives cut off the stream of glass as each mould passes. Experiments have been made with electric currents, and also with very strong streams of hot air for the purpose of severing the glass, but they have been abandoned.

Glass-making tools	France.
Glass-bottle making	America.
Crystal glass	America and Gt. Britain.
Window glass (machine)	America.

§ 5 Sewing Machines

THE Sewing Machine was invented in America long before the period under survey. Subsequently, however, owing to the enormous demand of these household necessities, factories were established in Great Britain, the machines being made entirely on American lines. The developments of the last forty years have been mainly American.

Many types of machines are now made, chief amongst which may be enumerated the following:

Domestic sewing machine	America.
High-speed machine	,,
Multiple spindle machine	,,
Machine for sewing-on buttons	,,
,, ,, making button-holes	,,
,, ,, leather and harness work	,,
,, ,, boot making	,,

§ 6 Piano Players

BOTH the origin and the development of Piano Players were American, and practically all the companies at present making them originated in that country.

Even when the trade necessitated factories being built in this country, the principal parts, particularly the mechanical portions, had to be imported in most cases from America.

The electric driving in connection with these piano players also originated in America.

Piano players	America.
Electric driving	,,

§ 7 Vacuum Cleaners

THESE machines were originated in America, and owing to quick appreciation by the American people, were rapidly developed there until the sale has now reached enormous proportions.

The British demand for these machines has grown to such an extent that factories have been built over here.

§ 8 Carpet Sweepers

MECHANICAL Carpet Sweepers were first made and developed in America, and whilst a certain proportion of the world's demand is made in England, by far the greater quantity is made in America.

§ 9 Safety Razors

IN Safety Razors, as in numberless other eminently useful articles, America has shown the way. After several attempts, the first commercially successful patent was taken out there by Gilette in 1895, but it was not until about eight years later that it was produced and put on the market.

The majority of the various makes of safety razors now being offered to the public are of American origin, and are made in U.S.A., although some factories have been established in this country to deal with British trade, which has grown rapidly, and now assumes enormous proportions.

This is clearly a case of a new idea having been given to the world, and developed by the United States.

§ 10 Thermos Flasks

THE idea was first conceived in England by Professor Dewar, who was experimenting with liquid air. He was greatly handicapped in using ordinary vessels, because of the difficulty of keeping the liquid air at the necessary low temperature, and also because the intense cold made it almost impossible to handle such vessels.

He could not get what he wanted in England. Accordingly he turned to Germany, getting into touch with a chemist there.

The idea was to make a vessel surrounded by a vacuum, and after repeated trials, a successful flask was made.

From this developed the Thermos Flask, which in the first instance was made in Germany, the whole thing being patented there. Eventually the trade-marks and patents were purchased by an English company for Great Britain and British Empire, the German company building a factory in England to manufacture the flasks.

The glass used in these flasks has to be of a particular character, slightly flexible, and all this was supplied by Germany: the metal parts, however, were made in England, and the whole assembled here.

On the outbreak of war the English company purchased the whole factory and equipment outright, and although considerable difficulty has been experienced in obtaining the raw material, particularly the glass, the manufacture of these flasks is now going along more successfully than it has hitherto.

Thermos flasks .. .. Gt. Britain, developed in Germany.

§ 11 Watches

By E. S. Daniells

The invention of small portable timekeepers is claimed by several nations.

The wearing of portable time-keepers on the person did not come into fashion until about the year 1600, or nearly a century after Peter Hele, of Nuremburg, had invented the mainspring (1510), which however was of small use until Jacob Zech, of Prague, in 1525, discovered a means of equalizing the elastic force of the mainspring.

Watches, which at first were box-shape, soon became oval in form, and were termed "Nuremburg Eggs." Watches continued to be made in this style for nearly a century.

The smallest were about two inches thick by three inches in diameter, and weighed about fourteen ounces. These unwieldy articles could not be carried in the pocket, but were either left at home, or dangled from a chain around the neck.

Watch-making was developed in England about 1600.

The watch-making industry of Switzerland was founded by an English watch being copied in 1679.

Up to about sixty years ago watches and clocks were made in England and on the Continent mostly by hand, very little machinery being employed.

The year 1856 or thereabouts saw the birth of the modern machine-made watch. A watch factory, started by Mr. A. L. Dennison, of Roxbury, Mass., U.S.A., was shortly moved to Waltham, which became famous as the birthplace of the Waltham watch.

While England chiefly stuck to the old-fashioned, hand-made methods of producing high-grade, high-priced watches, several American watch factories sprang into existence.

Each of these manufacturers made all the pieces that comprise a watch in one establishment, under one superintendent, duplicating the parts rapidly and accurately by machinery, thus attaining both cheapness and accuracy of design, as against the Swiss system of "farming out" the work and having the different parts made in the homes of various peasants.

Most of the American watch factories were devoted to making high-priced, high-grade, jewelled watches until the advent of the Ingersoll watch, about twenty-five years ago. At that date Robert Ingersoll & Bro. began to produce at Waterbury, U.S.A., cheap machine-made watches with standardized and interchangeable parts.

They made—

12,000 the first year,
87,000 the second,
225,000 the third,

and so on, until in the year 1915, when they made in this one factory over 5,000,000 watches.

About seven years ago Ingersoll Bros. purchased the Trenton Watch Co. Factory, which is devoted exclusively to making one model and size only, viz., 7-jewel watch. Two years ago they bought the old Waterbury Watch Factory, which is devoted exclusively to another single model.

During these sixty years, while machine-made, stem-wind watches have been developed in America, Switzerland, Germany, France, and Italy, the watch industry has declined in England.

The difference in the watch industry in England, as com-

pared with America and the Continent, might be indicated by the difference between "watch-makers" and "watch-manufacturers."

In Great Britain there are about 15,000 shopkeepers with the word "watch-maker" on their shop fronts and stationery, but there are only two or three watch "factories," one of the most important being that of H. Williamson Ltd., at Coventry.

The cheapest all-English-made-watch is retailed to the public at about 25s.

The Ingersoll Watch Company have an assembling workshop in London with several hundred employees engaged in assembling, timing, and testing several thousand watches per day for interchangeable parts made in the original Ingersoll Factory at Waterbury, which contains many almost human automatic machines.

These machines can neither think nor forget. The human element of error is thus eliminated, the importance of which may be illustrated by the fact that a difference of only one five-hundredth of an inch in the thickness of the hair-spring would mean a difference of six minutes per hour in the timing of a watch.

Timekeepers	Germany, Great Britain, Switzerland.
Machine-made watches ..	America, and afterwards Switzerland, Germany, France, Italy.

§ 12 Locks

THE most notable development in locks during the period under survey is the Cylinder Lock.

This lock is an American invention, which, though invented before our period (1860 to 1865), has found its development mainly during the last forty years.

The lock is based on an ancient Egyptian principle, and has been developed step by step, until to-day it is the most widely used of any.

Originally the key was flat; this gave way to the corrugated type, and later to the paracentric type, which affords the highest security together with the greatest number of key changes.

§ 13 Kitchen Cabinets

By Mrs. H. N. Casson

The Kitchen Cabinet is a clever combination of larder, dresser, and kitchen table. It takes up no more room than a dresser, yet it contains a cupboard for food supplies, a cupboard for tools and utensils, and a sliding metal work-table.

The larder section of the cabinet has carefully arranged places for flour, sugar, spices, flavouring extracts, salt, coffee, tea, etc., also a bread and cake box, dust- and mouse-proof.

The tool-cupboard is equally well arranged. There are special places for the rolling-pin, egg-beater, tin-opener, nutmeg-grater, etc. There are racks for lids and pie-dishes; shelves for saucepans, kettles, and mixing bowls, and drawers for cutlery and kitchen linen.

The sliding metal table is a great convenience. It is nickel-plated or porcelain-enamelled, therefore sanitary, and can be used for a mixing table or as a pastry board. When not in use it slides back, and takes up no room.

Not only are the many contents of the kitchen cabinet compactly arranged, its very doors carry convenience for the busy housekeeper. They show a want list for supplies, a bill file, a cook book, a food guide, giving economical and well-balanced menus for every day in the year, and a little money-tray for small change.

This cabinet of convenience is easily cleaned. The interior sections can be taken apart in three minutes, and as quickly restored. Also it runs easily on ball-bearing castors, so the place where it stands can be frequently cleaned.

In short, this cabinet is a miniature kitchen, fully equipped. It answers every need of the housekeeper. It fully merits its title of "the cupboard with brains." This useful innovation is American in inception and development.

§ 14 Margarine

Margarine was invented in France during the year 1870, to overcome the shortage of butter during the siege of Paris, but not until about ten years later did it attain any commercial consequence. The Dutch were the first to exploit it, and later the Danes. Continental countries generally have adopted its

use much more than Britain, which has only quite recently seriously realized its economic and other advantages.

It was first manufactured here by British and French firms, but up to 1890 no business of any volume was done. From this date however the consumption of margarine in the British Isles has slowly increased, although we are at present much behind the Continental countries in using it.

To compare some of the most recent available figures we have, during 1907: Great Britain, with its huge industrial centres and large classes of population, to which its economic advantages should particularly appeal, uses about 5 lbs. per individual per annum as against Denmark, 36 lbs. In 1912 the figure for Great Britain was about 8 lbs., as against 37 lbs. in Denmark, which latter country is almost purely agricultural.

Although the consumption of margarine has undoubtedly increased considerably since the outbreak of war, we are yet far behind in making use of an article which the most eminent dietetic authorities agree is as wholesome, palatable, and nourishing, when properly made, as butter, which is from three to four times dearer.

The special machinery needed in the manufacture of margarine is exclusively made abroad, chiefly in Holland.

As far as the technical side is concerned, it must be admitted that when once the English manufacturers had seriously take the question of margarine in hand, they have been able to hold their own in the progress which has been made in its manufacture. At the present moment approximately two-thirds of the consumption is imported, although there would be no call whatever for any importation, provided protective measures were taken.

Margarine	France.
Machinery for making margarine	Holland.

§ 15 Meat-Slicing Machines

The meat-slicing machine, now so extensively used in the provision trade and amongst caterers generally for the slicing of bacon and other commodities, was invented and placed on the market by a Dutchman, named Van Berkel, a provision merchant, who recognized the need of mechanical slicing to

give the most beneficial results to trader and public alike. He opened a factory for its manufacture in Holland, and introduced the machine into this country, making arrangements for its sale with an English house. Although the machine was first introduced on the Continent, Great Britain can boast that it was the first to appreciate generally the value of mechanical slicing—which fact is proved by the necessity which arose of laying down a factory in England solely for the purpose of dealing with the demand in this country.

The company now handling the machine interest themselves in no other kind of business, specializing on meat-slicing machines, and continually experimenting in the direction of improvements suitable for the trade in England, which is quite distinct from that of any other country. The same specialization is carried on elsewhere, and by this means improvements made (say, in America) which can be applied to the special machine for this country, are adopted, this idea being carried out through the whole of the various organizations.

By this system each separate organization studies the trade conditions prevailing, and the combined interests of all are co-ordinated towards the further improvements and perfection of the original invention.

Whilst the invention of this machine is due to a Dutchman, the credit for succeeding inventions and improvements may be equally divided between Holland, America, and England.

§ 16 Innovation Wardrobes and Trunks

THIS is a typical example of the way in which American inventiveness has been brought to bear on those commodities which tend to make life comfortable. The coats, etc., are hung upon suitable extending arms, which fold away compactly. Drawers or sliding shelves are also arranged with ingenuity.

The containing capacity of an innovation wardrobe of any given size is from two to three times as great as an old-fashioned one with drawers.

From this innovation wardrobe was evolved the innovation trunk—the first really distinctive departure from the ordinary travelling trunk. This originated and was developed in America. The same principle obtains in the innovation trunk as in the wardrobe.

The people of Great Britain have been undoubtedly slow to adopt the invention; up to the present time its appreciation and use have been mainly confined to America.

Innovation wardrobe .. .. America.
„ trunk .. .. „

SOCIAL

§ 1 The Modern Hotel

THE modern Hotel is the result of that American genius which finds such skilful expression in exploiting the pleasure-loving nature of man.

There are two outstanding reasons for its super-excellence:

1. Americans are by nature fastidious people, which makes them quick to appreciate all that adds to the refinement of everyday life.
2. They are preoccupied with business, and a very large proportion of the community are agents or high-grade commercial travellers—men who spend their lives on the railroads and in hotels. These hotels cater with great acuteness for the special needs of this important moving population.

Little by little the owners of hotels have wrought improvements which have transformed the old-time hostelry into what one might call Public Palaces. They have studied in particular the question of Service, Convenience, Construction, Decoration—achieving a result which is completely sybaritic. The Waldorf Astoria has, perhaps, the most far-flung reputation for luxuriousness.

For convenience' sake rooms are built *en suite*, and even single bedrooms have their private lavatories and bathrooms. Every room has a telephone, electric radiator, and hot and cold water on tap.

For the same reason the lift system is elaborate. There are fast-service lifts to the top floors, which may be twenty or more stories high; slow-service lifts for those lower down.

On the ground floor of these hotels there is a veritable network of expedients for eliminating time and trouble—Theatre Bureaux, Post Offices, Newspaper, Flower and Manicure Shops, and offices which silently record the exits and entrances of visitors, etc.

Central heating is of course a commonplace; and the baggage system has reached that perfection where no part of its method is shown.

Where convenience ends and luxury begins is a matter of personal feeling.

The same scientific forethought has been given to the matter of building and decoration. The up-to-date hotel is always of steel-frame construction, made fire-proof in every possible way; architecturally impressive, spacious, and airy. A real feeling for the *ensemble* characterizes the interior decoration. If this is in a period style, every detail is correct. Carpets, curtains, china, glass, all ornamentation, are in keeping with the central idea; and this gives the place an air of sumptuousness very attractive to a great democracy.

In matters of service the most meticulous thoughtfulness is shown. For example, guests are not only called at the hour they wish in the ordinary way, but a note is dropped through a slit in the door on which the time is written to prove the fact. A hotel in Warsaw has improved upon this plan. The visitor sets an electric contrivance which rings at the appointed hour, and continues to do so until a sleepy hand is stretched out to switch off the current.

As regards cuisine, the Continent, and especially France, had made a fine art of cooking long before the *Mayflower* sailed. But America to-day shows the same culinary skill, and perhaps even greater variety of food and flavour. Americans serve their meals with extreme daintiness, having many little table implements over and above the usual knife, spoon, and fork; and those etceteras which we consider luxuries, such as ice, they use in a number of delicate ways as a matter of course.

Briefly, Americans love publicity; they are the most sophisticated, travelled people in the world; and this has been the influence which has fostered their hotel organization, imitated by the Ritzes of Europe, but still unknown elsewhere.

§ 2 Cinema Industry

THE Cinematograph was invented in America. Great Britain, so far as development in the cinema is concerned, has held her own in the cinema theatre itself only. Practically all the

machinery used in the projection of cinema films comes from America and France. This is not because British engineers cannot make the machinery in question, but simply because they will not speculate. They will only manufacture to the extent for which they have firm orders. The French and American manufacturers, on the other hand, in the matter of cinematograph machinery, estimate the world's probable needs, decide what percentage of the total required they ought to supply, and manufacture accordingly. Consequently, they make in so much larger quantities than the English manufacturers that the latter cannot compete, except to a small extent in the home market.

Machinery for projecting cinema films has developed wonderfully during the last ten years. France and America are responsible for practically every improvement made. At least 90 per cent. of the cinematograph projectors in use in the British Isles and Colonies to-day are manufactured abroad.

With regard to the production of the films themselves, the English manufacturer has been so slow that he has allowed American manufacturers to form a taste in the British Isles for American films, with the result that 90 per cent. of the films shown in the cinemas in this country to-day are American. The American producers have created so large a market for their product that they can invest on a film production many times the amount of money that the English producers can afford to spend.

Cinema industry **France and America.**

§ 3 Optical Glass and Scientific Instruments

BY ROBERT J. FARMER

OPTICAL Glass of the highest excellence, and formulated into lenses for various scientific instruments, has been made in England since the early days of investigation by means of lenses, and through the gradual development of various instruments of precision. About the middle of last century, the English makers had no competitors of repute.

Microscopes.—Such time-honoured and still existing firms as Thomas Ross, Smith & Beck, Powell & Lealand, made microscopic objectives of world-wide excellence. Their only

competitor in early years was Hartnack, of Paris, until Zeiss, of Jena, made lenses from a glass evolved by Dr. Schotl and Professor Abbé at the Technical Glass Works of Messrs. Schotl at Jena in 1886. The special glass used in microscopy by Zeiss was made in combination with fluorite. Recently, a third type has been added by them from computations by Dr. Von Rohr, although many details in microscopic illuminations have been borrowed from us. The above are the most important foreign rivals to English lenses. The firms previously mentioned, together with Messrs. W. Watson & Son and Messrs. Swift, are well maintaining the pre-eminence of English microscopic objectives. Perhaps the highest magnification still belongs to England, *i.e.*, one-fiftieth, made by Powell & Lealand in the 'sixties. The principal improvements in optical glass hinge upon the Jena discoveries.

Opera and Field Glasses of the older or Gallalean order have been little made in England. Their principal source of production is France, and in lesser degree Germany and Austria. Such makers as Lemaire, Badoux, and Chavallier are well known, whilst Voightlander, of Vienna, has a wide reputation, especially amongst Americans.

Prismatic Field Glasses.—This great improvement in the general all-round efficiency in the field glass was the original invention of Professor Poro, of Milan, but Zeiss, of Jena, so arranged the system that it gave a much increased stereoscopic effect, apart from obtaining a higher magnification than formerly. This formation of glass is now entirely used for naval and military purposes, superseding the old Gallalean pattern. France rapidly took up the manufacture of these glasses. They are now also being made in England, thanks to the enterprise of some of our leading manufacturers.

Telescopes.—Telescopes and their lenses have always been made in England, although not of a large aperture until about 1877. The largest astronomical telescope objective then known, *i.e.*, 10 inches diameter, was worked from special discs cast by Messrs. Chance, of Birmingham. This lens was figured by Messrs. Thomas Cooke & Sons, of York. About the same time Professor Alvin Clark, of America, secured some similar discs, and worked them up in Boston. In this direction Great Britain, represented by Sir Howard Grubb, of Dublin, and Messrs. Cooke, of York, stand pre-eminent and far in advance of German manufacturers. Messrs. Ross, J. H.

Dallmeyer, Wray, etc., have for the past sixty years maintained a reputation of the first order for telescopes.

Tourist and other telescopes of more or less excellence have been, since about 1870, made and exported from France in great quantities.

Photographic Lens.—With regard to this section, probably as many types of new lenses have been invented in this country as abroad. The Ross Concentric; the Cooke Lens, the latter being the forerunner of all the recent lenses whose corrections are due to separation; the Ross Homocentric, Dallmeyer Stigmatic, Aldis Lens, Beck Isostigmar, and Neostigmar, are instances in point. The Goerz, Zeiss, Steinheil, and Voightlander are German lenses. Some of these are made under the Cooke patents, and are copies of English lenses. The French also make great quantities of photo-lenses of every description for cameras of the cheaper order, against which we are not able to compete. This remark applies also to instruments and apparatus in every department of science. These lenses are more or less copies of our own skill, some excellent, but many poor.

Lenses for a multitude of business and scientific purposes, such as condensers, the naturalist's magnifiers, map readers, and oculists' purposes, formerly worked in England, have for years past been supplied from the Continent, and later from America.

From the foregoing it will be seen, if we do not in this instance limit our survey to the past forty years, that British genius has contributed its share to the discoveries, which in their sum total go to make up the lens as it is known to-day. The British discoveries are apt to be forgotten and submerged by the Jena discoveries which followed, and which form by far the most important recent contribution to the science.

Where Great Britain has failed is in neglecting to manufacture what the world could buy in quantity, confining herself to the superexcellent, for which there is no demand. Hence at the outbreak of war the making of optical glass was one of our beaten trades, and the world, including ourselves, drew supplies from other countries. As America, the high-wage country, participated in this, the reason cannot be low wages. It is the all-too-familiar one, *i.e.*, the absence of the up-to-date and enterprising method of manufacture and distribution.

To sum up—the principal inventions for which the optical world generally is indebted to foreign countries are:—

Microscopes	Gt. Britain and France, perfected in Austria.
Opera and field glasses ..	France, Germany, Austria.
Prismatic field glasses	Italy, Austria, Germany.
Telescopes	Gt. Britain, America, France.
Photographic lenses	Gt. Britain, France, Germany, developed by America.
Optical glass improvements ..	Austria.

§ 4 Talking Machines

THE Talking Machine was invented in America.

In 1878 the first patents were taken out. By 1889 it had become a commercial possibility, and both instruments and records were actually manufactured and placed upon the market. For many years the manufacture of talking machines was almost exclusively an American industry.

These early instruments were all of the wax cylinder type, the disc machine, now nearly universal, not appearing until about 1898.

Both instruments and records were very expensive, and the first company formed to control the American patent then in existence ended in bankruptcy. Slowly though surely, however, public interest in the invention grew; the company was reorganized, and the new industry began to gain ground.

Europe too became interested, and it was not long before a large export trade from America was set on foot.

Later, stimulated by the high protective tariff which was imposing a heavy burden on the articles of this infant industry, the manufacture of talking machines was begun in Europe. France led the way; Germany followed. England came in slowly and long afterwards. Possessing Free Trade, she had not the same incentive to manufacture, and for years the talking machines and records sold in the English market were practically all imported.

A factor which notably hampered the early development of the industry in Europe, more especially as regards records, was the almost complete absence of local and topical music. The fact that practically all records were exported from America led to the various European countries receiving only such as were

suited to the American taste—"rag-time" for instance—not then as popular outside America as it appears to be to-day.

The demand for local music, the high tariff on imported records, and the "boom" caused by the introduction of the disc machine, were the chief stimuli to European production. One by one record factories made their appearance on the Continent.

England began to manufacture very late. In part this was because the similarity of language caused the imported American records to be more nearly suited to the taste of the British public, but chiefly because the spur of a large import duty was lacking.

The Gramophone Company built the first and what to-day is the only large instrument factory in Great Britain. Their idea was to found an entirely British industry. They succeeded. Their factory has now for some time past supplied the whole of Europe. To-day most of the concerns which make up the total of the British talking-machine industry manufacture their own records, although none of them, with the exception of the Gramophone Company, make their own instruments.

Some idea of the importance to which the talking-machine industry has attained may be gained from these facts concerning one branch of it. The Gramophone Company, better known by its famous trade mark, "His Master's Voice," possesses a capital of over seven millions sterling, and employs approximately 25,000 people. They spend vast sums annually on engaging famous singers and musicians to make their records, and they are perpetually working to raise the standard of this industry in Great Britain.

§ 5 Cameras and Popular Photography

It is almost unnecessary to point out that this most instructive recreation has been brought into universal general use by America, so that it has become popular both in Great Britain and on the Continent.

Probably the greater part of the credit for the development of this industry is due to one American firm, whose cameras are found all over the world; in fact, there is hardly a corner anywhere within the bounds of travel where these wonderful and

cheap instruments are unknown. There is no doubt that in the manufacture of cameras America produces overwhelmingly more than this country.

Obviously, the new ideas, developments, and inventions which go towards the construction of the popular camera, and have made it what it is, have for the most part had their source there. The manufacture of cameras in this country may be termed negligible. A magnificent opportunity presents itself for the development of a most lucrative industry in Great Britain. Probably it would be found on closer investigation that the excellence of the lens is traceable, not to America, but to Germany and other European countries.

PHOTOGRAPHIC CHEMICALS

Pyrogallic acid, hydrokinone, metol, amidol, and glycine—all these came almost entirely from Germany up to the date of the war.

Cameras	America.
Lenses	Germany and other Continental countries.

§ 6 Toys

By A. W. Gamage

The Toy trade has of late years been almost entirely in the hands of the Germans. Several causes have led to this, of which the following are the chief :—

(1) The German manufacturer had a protected home market of large size, and could work for a surplus stock, which he placed on the English market at competitive rates.

(2) He had low railway and shipping rates for export.

(3) He has always taken great pains to produce what is wanted.

(*a*) Dolls: Germany first produced life-like faces, and captured this trade, originally entirely French.

(*b*) Models of English railway engines were made, with correct details of numbering, names, colour, etc.

(*c*) Typical English railway stations were photographed and models made, correct even to advertisements.

(4) Many of the cheap wooden toys were made in the cottages of South Germany as a domestic amusement during the evenings, producing a small return.

Numerous instances could be given to show that the Germans have been great imitators, and that when a good thing has been made in England or France, they are very quick to obtain samples, and to reproduce it at a much lower price.

Animals (skin)	Germany.
Bicycles, etc.	Great Britain.
Books (coloured, children's) ..	Germany.
,, ,, expensive ..	Great Britain.
Cinematograph toys	Germany.
Coloured crayons	,,
Dolls	,,
Drums	Great Britain.
Engines	Germany.
,, expensive	Great Britain.
Games (parlour)	Mostly Germany.
Guns (Air)	Belgium.
,, cheap	Japan.
Magic lanterns	Germany.
Mechanical toys	,,
Meccano	Great Britain.
,, imitation	Germany.
Models	,,
Musical instruments	,,
,, ,, expensive ..	Great Britain.
Ornaments (Xmas tree)	Germany.
Noah's arks	,,
Pencil boxes	,,
Paints	,,
Railway toys	,,
,, ,, expensive	Great Britain.
Rifle (air), best	,,
,, ,, ...	America.
,, ,, cheap	Germany and Belgium.
Rubber toys	Germany.
Spun glass	,,
Teddy bears	,,
Trumpets	,,
Wooden toys	,,

§ 7 Barber's Shop

SEASONED travellers will admit that the greatest perfection in Barbers' Shops has been attained in Canada and the United States, most of the fittings and furnishing originating in the latter country.

In a first-class American barber's shop the evident desire is shown to anticipate every whim or demand of the most fastidious customer, unusual attention being paid to the question of cleanliness and the sterilization of the instruments and appliances used. Usually the floors and walls are tiled, the chairs constructed of iron, porcelain-enamelled, with nickel fittings, foot-rests and steps, the upholstery being in grain leather. These chairs, remarkable for their comfort and convenience, are revolving, and by tilting can be made reclining; they are also easily and quickly raised and lowered hydraulically by the movement of a hand lever. The walls along each side where the chairs are placed are lined with neat, handsome mirror-cases with dainty white enamelled wash-basins, one for each chair. The plumbing, entirely in open style, provides hot and cold water taps, also shampoo hose taps, arranged to combine the flow of both hot and cold water, so as to regulate the water temperature to any required degree.

The tonsorial artists are garbed in white duck uniforms and shoes, each man being a master of his profession before admission to such shops. While he attends to the customer's needs, the latter may if desired have a bootblack to shine his shoes, using for the purpose a portable outfit.

At the same time a manicurist, with the aid of a small portable basin attached to a slot on the chair-arm, attends to the care of the hands.

Undoubtedly in British shops the client receives as good personal service, but the furniture, chairs, appliances, and general finish of the shop are far below the American standard. The comfort due to the ingenious improvements on American barber chairs is sadly lacking, the chair- and appliance-makers in the United States having developed the requirements of the trade far in advance of any other civilized country.

§ 8 Soda Fountain and American Bar

Our countrymen, accustomed to a restricted variety of non-alcoholic drinks, are amazed to see in Canada and America the beautiful and elaborate Soda Fountain, where literally hundreds of different kinds of temperance drinks are served at prices from five cents upwards. Eatables are also obtainable when required.

The equipment of these fountains must be seen to be appreciated—walls, floors, and counters of marble, attendants in spotless white, all utensils nickel-plated, and scrupulously sterilized and clean. Nothing more hygienic and wholesome can be conceived.

An idea of the volume of this social attraction may be gathered from the fact that there are to-day in America 75,000 soda fountains. To that country we owe the development of the soda fountain, which, when contrasted with the inadequate sale and distribution of non-alcoholic drinks in this country, is evidence of the extraordinary versatility of the American people. In Great Britain our drinks are more or less the same as those of our grandfathers, whereas in America new varieties are forthcoming every day.

The relative number of soda fountains to saloons in the U.S.A. is 75,000 to 150,000.

THE AMERICAN BAR

What the soda fountain has done by way of developing the variety of non-alcoholic drinks the American Bar has done in alcoholic. Here an unlimited variety may be obtained, served icy cold, and delicately flavoured.

This is an essentially American development, and gives to the American an infinite variety of drinks, whilst Britons are more or less still confined to the beer and whisky of their ancestors.

§ 9 Popular Amusements

THE majority of developments of a thrill-producing nature, now to be found at popular resorts, White Cities, etc., are of foreign origin, and are in striking contrast with the simpler amusements in vogue at the Old English Fairs. A list is appended :—

The Switchback (about 1884 to 1887)	America.
The Figure 8 (1908)	„
The Scenic railway	„
The Safety racer	„
The Waterchute	„
The Toboggan	Canada.
The Ocean wave (1890)	Gt. Britain.
Looping the loop	(?)

THE HEALING ART

As an interesting example of the extent to which we have depended upon other countries for advances in the Healing and Curative art, the following statements are attached.

Comment seems superfluous beyond this, viz., that there is clear evidence that the new ideas, discoveries, and developments in this branch of human activity have for the most part had their source abroad.

It is highly significant that the contention upon which the glossary is based should be borne out in the case of this learned profession.

Statement	A	deals with	Bacteriology and Pathology.
,,	B	,,	details of investigations and new treatments.
,,	C	,,	medicinal substances.
,,	D	,,	appliances.
,,	E	,,	proprietary medicinal articles.

STATEMENT A

§ 1 Bacteriology and Pathology

ALTHOUGH the foundations of Bacteriology were laid by a Frenchman (Pasteur) and an Englishman (Lister), the superstructure has been reared largely by German scientists. This will be evident from the following list of the most important disease-producing organisms, all of which were discovered by German bacteriologists: Pneumonia, Meningitis, Gonorrhœa, Tuberculosis, Glanders, Actinomycosis, Anthrax, Typhoid, and Paratyphoid fevers, the Bacillus enteritidis, the common Colon bacillus, Diphtheria, Tetanus, Cholera, Influenza, Relapsing fever and Syphilis, and two of the organisms of Dysentery. Of the remaining diseases, which comprise a smaller number than the above, the honours of the discovery of the Causal micro-organisms are shared by British, French, Italian, American, Russian, Japanese, Norwegian, and Belgian bacteriologists.

In one particular section of pathology and bacteriology, namely Tropical Pathology, the bulk of the discoveries have been made by British, French, and, to a less degree, Italian scientists. This is correlated with the fact that these three nations, and especially the first two, have a large number of

overseas dominions and colonies, in the economic development of which a study of the prevailing diseases of man and the lower animals, with a view to their prevention and cure, plays an all-important part. Since the pioneer work was done, much knowledge has been gained by American, German, Japanese, and Portuguese investigators, in addition, of course, to those of the three nations already mentioned. As is the case in many other fields of knowledge, once the discovery has been made, the Germans have not been slow in realizing its importance and following it up, bringing into activity all their organized energy, and their faculty of "plodding" along one line of investigation for a long time and with minute attention to details.

It is probably correct to say that the output, *by the Germans alone*, of scientific work in bacteriology and pathology, as evidenced by published papers, is equal to that of the rest of the civilized world. As a result, we find that the most widely-read periodicals on these subjects are German; the French, American, British, and Italian are a long way behind. The same with text-books and atlases of bacteriology and pathology. Whereas the medium-sized or students' manuals occur in most of the important languages, the larger and authoritative manuals or reference works are almost exclusively German.

Coming now to the subject of "Immunity" or Susceptibility to Disease, and to the prevention of disease by serums and vaccines, which has played so great a part in the present war, we find the honours are by no means entirely—or even mainly—with the Germans. The introduction and popularization of vaccines for the prevention of typhoid and similar fevers is due largely, if not entirely, to British scientists. The "serum" treatment of diphtheria, which has resulted in the saving of the lives of many children, was introduced by a German; whereas the "serum" treatment of tetanus (lock-jaw) was rendered possible by the isolation, in pure condition, of the tetanus bacillus by a Japanese scientist. A few further points in this connection must be noticed. In the practical study of bacteriology various forms of glass apparatus, various dyes and "culture-media" (for the artificial propagation of micro-organisms) are needed. To our cost, we are now discovering that we have hitherto allowed ourselves to become almost entirely dependent on Germany, and to a less extent, on Austria for these.

What are the reasons for the superiority of the Germans in the subjects under consideration? They are partly general and partly special.

The most important of the general reasons are:—

(1) The natural aptitude of the Germans for continued application to one particular subject, and for thoroughly working it out in all its details.

(2) The better equipment and organization of the work in the laboratories under a professor who devotes all his time to the work.

Among the special reasons the following may be given:—

(1) The fact, just mentioned, that in the German laboratories the work is better organized and equipped. The professor, who is the head of the department, has a staff of skilled assistants who do most of the teaching under his direction, as well as a certain amount of research work. This leaves the professor time to organize and direct the research work in his laboratory, as well as to carry out some himself.

(2) Owing to subsidies from the State, or endowments by private individuals, and possibly too, because the German standard of living is not so high as our own, German bacteriologists and pathologists do not need to supplement their salaries by doing much private practice in bacteriology. In that way, all their time and energy can be utilized in teaching and carrying out original investigations.

What we need in this country is more recognition by the State than has hitherto been given to it, of the great importance of organized research in bacteriology—from the point of view of the causation, prevention, and treatment of diseases in man and the lower animals, the bacterial contamination of food, and the bacteriology of industries, such as agriculture, brewing, dairy-farming, etc.

STATEMENT B

§ 2 Investigations and New Treatments

Medicine:

The advances in the knowledge of medicine during the past twenty-five years are for the most part the development of the work started by Pasteur.

The work of Pasteur on rabies, and Lister on wound infection, may be taken to precede the period of twenty-five years.

Diphtheria:

Antitoxin was first prepared and used by Roux in 1894, although the organism of diphtheria had been described several years before by Klebs and Loeffler. The preparation of the antitoxin was the outcome of previous years of work on the toxin by Roux, Yersin, Behring, and Kitasato.

Cholera:

Protective inoculation against cholera was due to the work of Haffkine, although the organism was first described by Koch.

Plague.

Kitasato and Yersin describe the organism of plague.

The evidence that the plague was carried by the rat-flea to man was the result of the Plague Commission sent out from England in 1898.

The serum treatment of plague was then introduced by Yersin.

The protective vaccine against plague was the work of Haffkine.

Typhoid Fever:

The organism was described by Eberth. Widal described the specific nature of the blood.

Wright, of London, introduced protective inoculation, the benefits of which have been so great.

Malta Fever:

The organism was first described by Colonel Sir David Bruce. In 1904 the organism was found in goat's milk, and the carrying of the infection by this means to man was proved.

Malaria:

Laveran first described the plasmodium malaria. Sir Patrick Manson suggested the transmission of malaria from man to man by the mosquito. Sir Ronald Ross worked out the whole cycle of the plasmodium through the mosquito to man.

Yellow Fever:

The proof that yellow fever is conveyed from patient to patient by the Stegomyia mosquito, was proved by the American Commission, consisting of Reed, Carroll, Lazear, and Agramonte.

Syphilis:

The Spirochaeta pallida, the causal organism of syphilis, was described by Schaudinn, the blood reaction by Wassermann, and the treatment by salvarsan by Ehrlich.

Poliomyelitis:

The transference of this disease from man to monkeys was shown by Landsteiner and Popper, but the method of propagation was due to the work of Levaditi, Flexner, Lewis, and Roemer. The causal organism was first described by Flexner and Noguchi.

Preventive treatment has yet to be discovered.

Cerebro-Spinal Meningitis:

The organism was described by Weichselbaum and Still, of London. Serum treatment was instituted by Flexner, of the United States.

Further work on the nature of the organism was done by Arkwright, Gordon, of London, and others. Preventive treatment has not yet been discovered.

Sleeping Sickness:

The discovery of the Trypanosoma was due to Colonel Sir David Bruce, who worked out the life history in the tsetse fly.

Internal Secretions:

The vast field of the investigation of the ductless glands has practically been explored during the past twenty-five years. The effect of absence of thyroid secretion in producing myxœdema was experimentally shown by Sir Victor Horsley, and Kocher, of Berne; the replacement of the gland by injection, by feeding, by Hector Mackenzie and Murray (England).

The supra renal, pituitary, the ovary and testes have all in turn been investigated by observers of all nations.

Heart.

Investigated by the polygraph by Mackenzie, and by the string galvanism by Gibson, Enthoven, and Lewis.

X-ray:

The discovery of the X-ray was due to Roentgen, but the application to medicine in all its branches is due to the work of observers of all nations.

Radium:

The discovery of radium was due to Madame Curie, but the application to medicine was made by various workers of all nations.

Medicine	Pasteur	French.
	Lister	British.
Diphtheria	Roux	French.
	Klebs	German.
	Loeffler	„
	Yersin	French.
	Behring	German.
	Kitasato	Japanese.
Cholera	Haffkine	Russian or Polish.
	Koch	German.
Typhoid fever	Eberth	„
	Widal	French.
Malta fever	Col. Sir David Bruce	British.
Malaria	Sir Patrick Manson	„
	Laveran	French.
	Sir Ronald Ross	British.
Yellow fever	Reed	United States.
	Carroll	„ „
	Lazear	„ „
	Agramonte	„ „
Syphilis	Schaudinn	German.
	Wassermann	„
	Ehrlich	„
Poliomyelitis	Landsteiner	Austrian (?)
	Popper	(?)
	Levaditi	(?)
	Flexner	United States.
	Lewis	(?)
	Roemer	(?)
Cerebro Spinal Meningitis	Weichselbaum	German.
	Arkwright	British.
Internal secretions	Sir Victor Horsley	„
	Hector Mackenzie	„
Heart	Gibson	„
	Enthoven	Dutch.
X-ray	Roentgen	German.
Radium	Madame Curie	French.

STATEMENT C

§ 3 Medicinal Substances

At the outbreak of war the sources of supply of the above were as stated below:

Salicylic Acid	These were produced almost entirely in Germany. Supplies are now being obtained from America, France, and Switzerland.
Sodium Salicylate ..	
Aceto-salicylic Acid ..	
Acetanilide	These were made in England, but a very much larger amount was imported, chiefly from Germany.
Atropine	
Cocaine	
Quinine	
Acetic Acid (pure) ..	This came chiefly from Holland, Belgium, Germany.
Phenacetin	The first two came entirely from Germany, the others from Germany, Switzerland, and France.
Phenazone	
Phenolphthalein ..	
Resorcin	
Benzoic Acid (synthetic)	These came from abroad, chiefly from Germany.
Tannic Acid	
Lactic Acid	
Bromine	These were obtained chiefly from Germany.
Bromide of Potassium..	
Permanganate of Potash	The manufacture was entirely in German hands.

Many other synthetic chemicals and medicinal substances came largely from abroad. The above are the chief.

STATEMENT D

§ 4 Appliances

In the case of surgical instruments, owing to improved methods, and the larger quantities manufactured, the Germans were able to produce at much lower prices than the English. This was particularly the case with such articles as scissors, forceps, and similar small articles which they manufactured from steel stampings in place of hand forgings used mostly in this country. Whilst an article made from a steel stamping was not quite so reliable as the hand-forged article, breakage was a matter of very rare occurrence, and the goods for general purposes were practically as efficient.

In the matter of heavier steel instruments, such as midwifery and obstetric forceps, etc., the English houses held most of the trade, for whilst the German prices were somewhat lower, the difference was not sufficient to influence business.

The Germans and the Austrians were undoubtedly very skilful makers of delicate instruments used for operations on the mouth, throat, eye, nose, etc. Several firms, both in Berlin and Vienna, specialized in such instruments, and practically supplied the whole world.

Very few veterinary instruments were imported from Germany; nearly all sold in this country were of English manufacture.

By their improved methods of manufacture the Germans practically monopolized the whole trade in cheap cutlery. The Americans are trying to capture this trade, but their goods do not compare in the slightest with the German-made article, being very brittle.

In electrical instruments and appliances as used in electrotherapy, the manufacture has (generally speaking), originated in America, and been carried out there on a much larger scale than here, although now it is possible to obtain all types of good quality made in Great Britain.

The glass-ware lamps, etc., used in X-ray treatment were all German or Austrian at the outbreak of war, and we are unable to state whether such are now obtainable of British manufacture or not.

Mechanical vibrators are also of American origin, and principally made there.

STATEMENT E

§ 5 Proprietary Medicinal Articles

GREAT BRITAIN is indebted to America for most of the best productions of *advanced pharmacy* which reach the public through the prescriptions of the medical profession, and direct to the buyer at the chemist's counter.

The high character of many American medicines and pharmaceutical articles, together with American enterprise in publicity methods, and the attractive style of marketing their productions, have enormously stimulated and influenced manu-

facturers in this country. In addition it must be stated that large quantities of patent medicines, more or less worthless, have had in the past their origin in America, and have sold just as long as good advertising was continued, disappearing when such was discontinued. Germany too sold many well-known proprietary articles on this market in large quantities in pre-war days, but since the war substitutes have been forthcoming in some instances.

There has been a very large importation of toilet articles, such as tooth paste, hair wash, perfumery, etc., the first two emanating principally from America, the last from France. Here again advertising is an important factor.

In conclusion, there appears to be no reason why our dependence upon foreign countries should continue, for just as soon as the Briton learns how to advertise and place his goods before the public in as attractive a form as the foreigner, the trade will be his.

The actual knowledge as to how to produce articles of this nature is not lacking amongst British manufacturers of pharmaceutical products; their failure to take a more prominent place may be said to be due primarily to their inability to market the goods as efficiently as the foreigner.

§ 6 Dental Materials and Appliances

PROSTHETIC and Operative Dentistry was studied in America a long time ago before attention was given to the question here.

Consequently Americans produced dental materials and appliances long before serious developments took place in this country. This lead they still maintain to the present day in many important lines, the reason being that they have employed the very best brains regardless of cost. Qualified dentists are employed in the manufacture, and even in the sale of goods. Thus professional science and industry join hands.

The result is—new ideas, new articles, and a better education among the public as to the importance of dentistry. This again has increased the demand for the best class of goods, and the larger the demand, the easier it is to establish the manufacture of goods on a scientific basis.

German competition has been a very serious menace in the last few years. It is a well-known fact, however, that the goods produced in Germany have not been original, but have been copies of well-known American and English goods. In most cases the German-made article was of medium quality and low price.

The American and German manufacturers achieved predominance over the Englishman in the manufacture of dental articles for the following reasons:—

(i) Better education, training, and remuneration of workmen.
(ii) Generous rewards offered for new ideas.
(iii) Specialization in the manufacture.
(iv) Heavy capital outlay in up-to-date buildings and machinery, and in catering for large demands.

With regard to (iv) an American dental spittoon manufacturer will spend £10,000 in machinery for making spittoons; the British manufacturer will not spend one-twentieth of that sum. A German bur manufacturer will spend £10,000 to £15,000 in machinery, whereas the British manufacturer would not think of spending even a fraction of such an amount.

The Banking System of Germany has greatly helped the development of dental training and manufacture, whereas in England such facilities do not exist.

The demand for dental articles in any given country taken singly is very limited; consequently the manufacture of dental articles cannot be made on scientific lines for the consumption of the home market alone. America and Germany realizing this have catered for a world's consumption. They have studied therefore the customs, languages, currencies, weights and measures, etc., of all foreign countries. The British dental manufacturer has not done this to any great extent.

This point may be illustrated by the following:

Artificial Teeth.—America is to-day the possessor of two-thirds of the artificial tooth trade of the world. She has obtained this trade through the modern methods of production, improvement in the porcelain, in the shades, and in the forms, whereas the methods of the British manufacturer are much the same as they were fifteen or twenty years ago.

Dental Operating Chairs.—A large number are made in the United Kingdom, good articles meeting with a ready sale. America, however, produces a distinctly higher grade of chair,

which appeals to the high-class practitioner. Germany has sold an enormous quantity of operating chairs in this country. They copied well-known makes, and owing to specialization and system, they were able to sell a fair article at a very low price.

Dental Engines and Lathes.—No electric machines for dentists' use are manufactured in this country. This is probably due to the fact that the British manufacturer was not willing to specialize in this kind of work, or to build a special plant, which would necessitate a large expenditure. The Americans and the Germans are to-day the world's suppliers of these goods.

Electric Air Compressors.—The possession of this trade is solely in the hands of certain American firms.

Dental Engines, Handpieces, and Parts.—These were the inventions of American firms, and have been copied extensively by German houses, which specialize in their manufacture. This enables them to turn out goods of fair quality at a very low price.

Dental Excavating Burs.—In spite of the heavy capital required for installing a modern bur plant, automatic machines for this purpose were invented in America, and copied by Germany. At present no modern bur-making machines exist in the United Kingdom, except a few purchased from Germany by one particular firm.

Dental Broaches.—These articles are mainly manufactured by the Swiss and the French, who have, owing to their specialization, retained the greater part of this business for many years.

Carborundum Wheels, Discs, and Points.—These are an American invention, and of American manufacture.

Fillings.—Filling materials, such as dental cements, were to a large extent in the hands of the Germans. The reason probably was due to the greater development of chemical knowledge in that country. Of late years, a number of the best cements and filling materials have been originated and produced in Switzerland. Translucent dental cements were discovered in England by Thomas Fletcher, of Warrington. The idea was taken up in Germany, and considerably developed. It was further improved by a Swiss firm, so that the article produced is recognized everywhere as being the best.

Tantalum Instruments.—The commercial production of this material is German.

Hypodermic Needles.—This article is common to all countries. A few years ago a new system of adapting it to the syringes was invented. A German manufacturer specialized in this article, and until the war controlled the world's market.

Casting Outfits.—The apparatus for the casting of dental inlays was the invention of an American, improved upon by a Frenchman, and afterwards produced by a number of manufacturers in all countries.

Gutta Percha.—The bulk of the gutta percha used for filling teeth comes from America.

Rubber Dams.—These are produced in all countries, but of late years a Hamburg firm seems to have obtained the control of the bulk of the business, owing to improved quality and lower price.

Local Anæsthetics.—The bulk of the local anæsthetic trade of the world seems to be in the hands of Americans. Owing to specialization, they seem to have been able to improve upon the English article.

Dental Suctions for Artificial Plates.—The manufacture of this article originated in this country. It was developed in Germany, and of late years the greater part of these articles have been supplied by Germany.

Artificial teeth	perfected in America.
Dental operating chairs	America and Germany.
Dental engines	„ „
Dental lathes	„ „
Electric air compressors ..	America.
Dental handpieces and parts ..	America, developed in Germany.
Dental excavating burs	„ „
Dental broaches	Switzerland and France.
Carborundum wheels	America.
„ discs	„
„ points	„
Fillings	Germany.
Dental cements	„
Translucent dental cements ..	Gt. Britain, developed in Germany and Switzerland.
Tantalum instruments	Germany.

Hypodermic needles	All nations, developed Germany.
,, syringes	,, ,, ,, ,,
Casting outfits	America and France.
Gutta percha fillings	America.
Rubber dams	Germany.
Local anæsthetics..	America.
Dental suctions for artificial plates	Gt. Britain, developed in Germany.

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